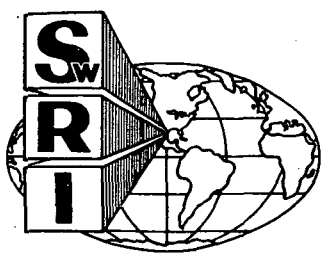
SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM

by
David F. Culclasure
Linda Eckhardt

FINAL REPORT
24 August 1971 - 24 August 1972

Contract No. NASW-1867
SwRI Project No. 13-2538

Prepared for
Chief, Dissemination Branch, Code (UT)
Technology Utilization Division
Office of Technology Utilization
NASA
Washington, D.C. 20546



SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

SOUTHWEST RESEARCH INSTITUTE
Post Office Drawer 28510, 8500 Culebra Road
San Antonio, Texas 78284

SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM

by
David F. Culclasure
Linda Eckhardt

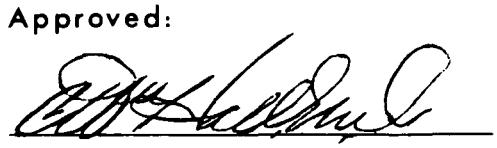
FINAL REPORT

24 August 1971 - 24 August 1972

Contract No. NASW-1867
SwRI Project No. 13-2538

Prepared for
Chief, Dissemination Branch, Code (UT)
Technology Utilization Division
Office of Technology Utilization
NASA
Washington, D.C. 20546

Approved:



C. William Hall, M.D.
Director
Department of Bioengineering

ABSTRACT

The NASA Biomedical Applications Team at Southwest Research Institute serves as an information and technology interface between NASA and the biomedical community. In an ongoing experimental program, a team composed of a multidisciplinary group of scientists and engineers, applies aerospace technological developments to biomedical research problems. The Southwest Research Institute Biomedical Applications Team is presently staffed by:

C. William Hall, M. D.
Ray W. Ware, M. D.
David F. Culclasure, Ph.D.
Charles J. Laenger, Sr.
Robert L. Wilbur
Samuel G. Schiflett
Earl K. Calvert
Linda L. Eckhardt
Dennis C. Jamvold

The following 60 medical institutions participated in the Biomedical Applications Program during this report period.

M. D. Anderson Hospital
Houston, Texas

Arkansas Enterprises for the Blind, Inc.
Little Rock, Arkansas

Baylor University Medical Center,
Jonsson Hospital
Dallas, Texas

Baylor University Medical School
Houston, Texas

Brooke General Hospital
Ft. Sam Houston, Texas

Callier Hearing and Speech Center
Dallas, Texas

Caruth Memorial Rehabilitation Center
Dallas, Texas

Children's Convalescent Hospital
Oklahoma City, Oklahoma

Children's Hospital of Los Angeles
Los Angeles, California

Community Mental Health Service
San Diego, California

Criss Cole Rehabilitation Center
for Blind
Austin, Texas

Doheny Eye Foundation
Los Angeles, California

Fitzsimmons General Hospital
Denver, Colorado

Gallup Indian Medical Center
Gallup, New Mexico

General Rose Hospital
Denver, Colorado

Hollywood Presbyterian Hospital
Los Angeles, California

Hot Springs Rehabilitation Center
Little Rock, Arkansas

Huntington Memorial Hospital
Pasadena, California

Loma Linda Medical Center
Loma Linda, California

Los Angeles County Hospital
Los Angeles, California

Mercy Hospital
Birmingham, Alabama

Morton Cancer and Research Hospital
Dallas, Texas

Northwestern University Medical School
Chicago, Illinois

Rancho Los Amigos Hospital
Downey, California

Rosewood General Hospital
Houston, Texas

St. Josephs Hospital
Phoenix, Arizona

Social Security Disability Insurance
Texas Rahabilitation Commission

Scott and White Hospital and Clinic
Temple, Texas

Texas A & M University
College Station, Texas

Texas Association for Retarded Children

Texas Rehabilitation Commission
Austin, Texas

Texas Institute for Rehabilitation and Research
Houston, Texas

University of Alabama Dental School
Birmingham, Alabama

University of Alabama Medical School
Birmingham, Alabama

University of Arizona Medical School
Tucson, Arizona

University of Florida
Gainesville, Florida

University of Florida Medical School
Gainesville, Florida

University of Iowa Medical School
Iowa City, Iowa

University of Oklahoma Medical School
Oklahoma City, Oklahoma

University of Southern California Medical School
Los Angeles, California

University of Texas
Houston, Texas

University of Texas Medical Branch
Galveston, Texas

University of Texas Medical School
San Antonio, Texas

University of Texas Southwestern Medical School
Dallas, Texas

University of Utah Medical School
Salt Lake City, Utah

University of Washington Medical School
Seattle, Washington

University of Wisconsin
Madison, Wisconsin

Veterans Administration Hospital
Albuquerque, New Mexico

Veterans Administration Hospital
Bay Pines, Florida

Veterans Administration Hospital
Birmingham, Alabama

Veterans Administration Hospital
Denver, Colorado

Veterans Administration Hospital
Gainesville, Florida

Veterans Administration Hospital
Long Beach, California

Veterans Administration Hospital
Memphis, Tennessee

Veterans Administration Hospital
Sepulveda, California

Veterans Administration Hospital
Temple, Texas

Veterans Administration Southern Research Support Center Hospital
Little Rock, Arkansas

Vocational Rehabilitation, State of New Mexico
Los Curces, New Mexico

Western Research Support Center
Sepulveda, California

Wilford Hall Hospital
Lackland Air Force Base, Texas

Interaction with six new institutions was begun during this report period. In addition, the team identified forty eight new problems. 14 potential technology applications were identified and 19 technology applications were accomplished. On August 24, 1972, the team had 167 active problems under investigation.

Applications of aerospace technology achieved during this period include a number of significant accomplishments. Medical instrumentation developed includes an ultra-low bandpass amplifier for gastro-intestinal electric potentials, a non-encumbering EEG electrode assembly suitable for long term sleep research studies, an accurate cardiac telemetry system for active subjects, and an intracranial pressure measurement device. In the field of rehabilitation, a warning system for the deaf, a new type tracking cane for the blind, and an improved control mechanism to expand self-sufficiency of quadripligics have been designed and developed by Bromedical Applications Team engineers.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont'd)

I. INTRODUCTION

Since its inception, the National Aeronautics and Space Administration has been discovering new things about materials, machines, and human beings, as well as the earth, the moon, and the universe. Mankind's gain would be slight if these many discoveries were not widely shared.

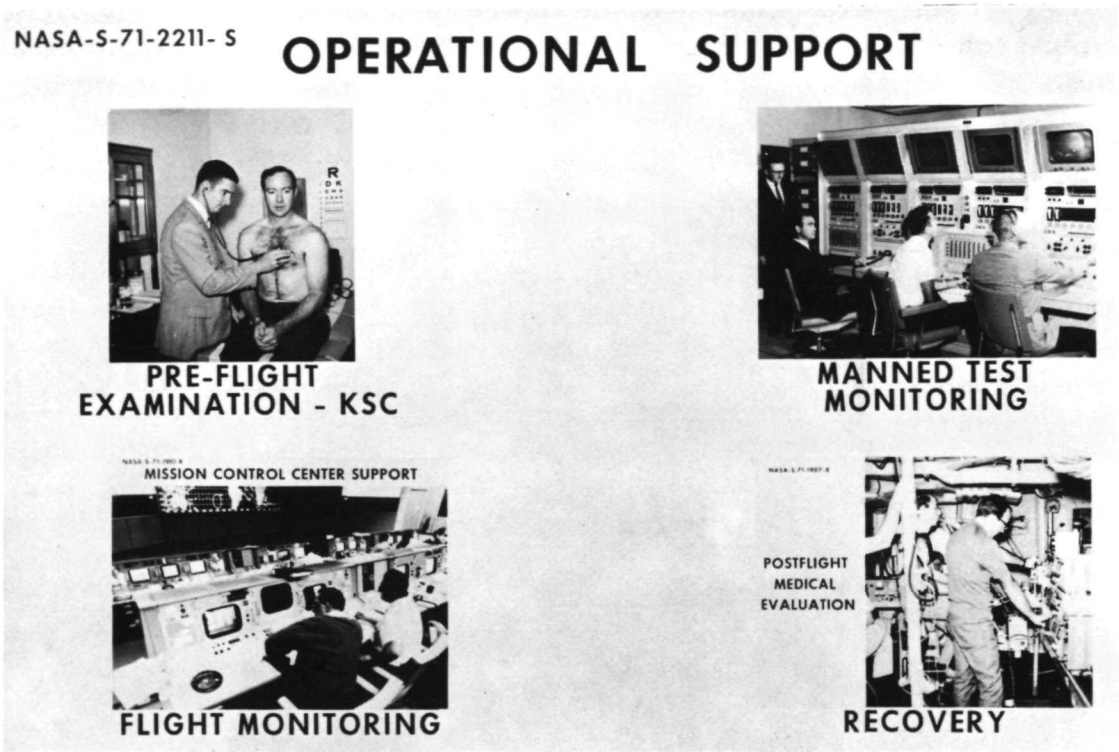


Figure 1. Examples of NASA developed technological and informational expertize which is being applied to benefit mankind.

Recognizing this, the Congress has directed that NASA provide for the widest practicable dissemination of aerospace related information for the benefit of mankind. The NASA Technology Utilization Program, created in response to the Congressional mandate, embraces four basic purposes:

- To increase the return on the national investment in aerospace research by encouraging additional use of the results;
- To shorten the time gap between the discovery of new knowledge and its effective use in the public sector;

- To aid the movement of new knowledge across industrial, disciplinary, and regional boundaries; and, importantly,

- To contribute to the development of better means of transferring knowledge from its point of origin to other points of potential use.

Technology Utilization Programs which may be used by those outside of the space program range from announcements of promising new technology (NASA Tech Briefs) and special publications such as Technology Utilization Surveys covering NASA contributions to entire areas of technology to more dynamic problem-solving programs such as NASA's Biomedical Applications Teams.

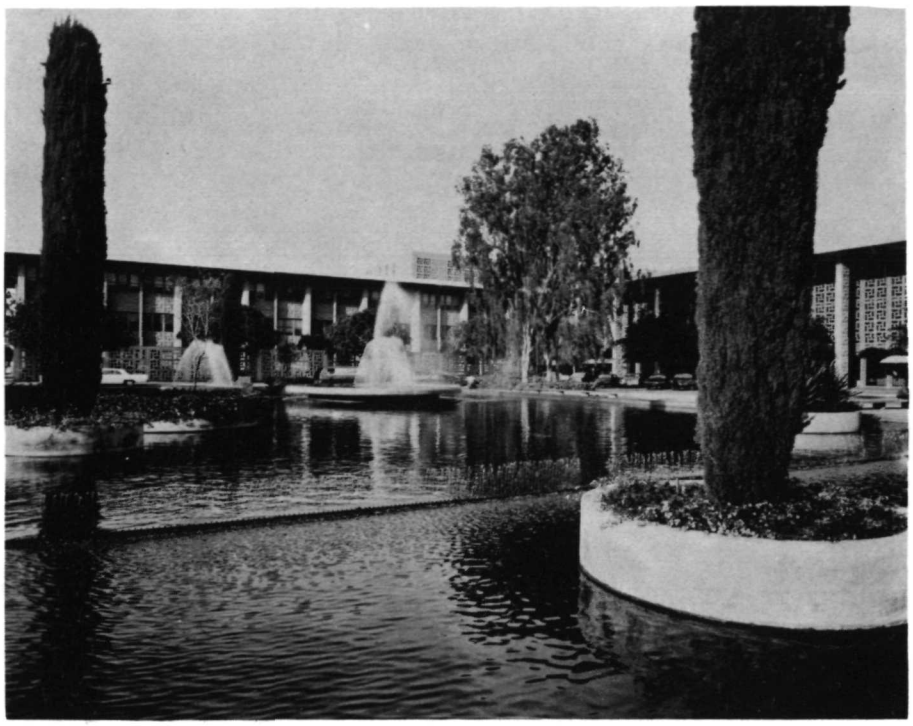
Figure 2. Biomedical Applications Team scientists and engineers conferring with medical personnel to some current problems facing biomedical research today.

These teams consist of small groups of biological and physical scientists located at selected independent research centers. Each team is equipped with firsthand knowledge of areas of active research at NASA and contractor facilities, is familiar with NASA's computer-indexed collection of scientific and technical information, and is adept at designing search strategies which optimize information retrieval. The teams thus represent a human connection between NASA, its research centers and contractors, and the

biomedical researchers and practitioners at work in medical schools, institutes and hospitals. The teams filter, encode, and amplify communications, functioning as an interface between the aerospace and biomedical researchers, helping to identify problems and matching them with innovative solutions from aerospace technology.

Three Biomedical Applications Teams are currently in operation serving the medical community across the United States:

Biomedical Applications Team
Research Triangle Institute
P.O. Box 12194
Research Triangle Park
North Carolina 27709



Biomedical Applications Team
Stanford University School of Medicine
Division of Cardiology
300 Pasteur Drive
Palo Alto, California 94304

Biomedical Applications Team
Southwest Research Institute
8500 Culebra Road
San Antonio, Texas 78284

Figure 3. Location of Biomedical Applications Teams

THE FIRST STEP--PROBLEM ACCEPTANCE

The teams direct their resources towards solving problems which (1) bear most meaningfully and directly upon advancing research and development in the biomedical community and (2) are likely to benefit from some aspect of prior or ongoing research and development being conducted as part of the Nation's space effort. Several years' experience in the technology applications process, plus an awareness of the ongoing aerospace research effort, enables the teams to realistically evaluate the probability of an application being effected in a given case. Problems submitted are accepted--or declined only after careful study by the team.

THE SECOND STEP--PROBLEM DEFINITION

Each problem accepted by the team is stated in functional, nondisciplinary language which is understandable both by aerospace physical scientists and medical researchers in the form of a Problem Statement. This statement is used not only to devise a strategy for computerized searching of the NASA Aerospace Data Bank but may also be circulated to Technology Utilization Officers at NASA field installations and research centers, who will seek possible solutions to the problem from NASA's in-house research staff.

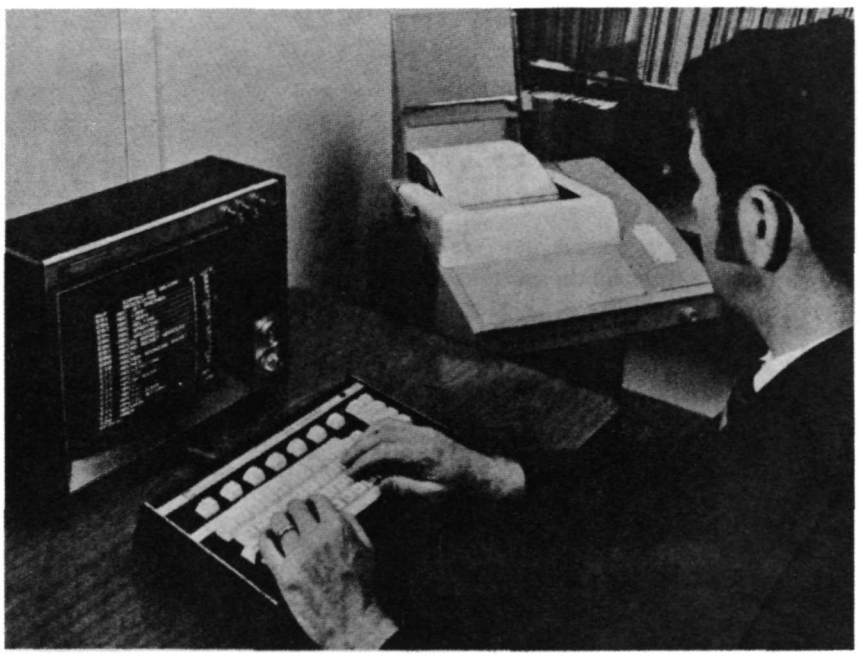


Figure 4. Computerized searching of NASA data bank at the RECON terminal provides almost instant technical information on a given topic.

Two points deserve emphasis at this point. The first is that the Biomedical Applications Program is a problem-solving endeavor as opposed to a research-oriented literature searching activity; the Teams' activities center upon seeking solutions for discrete, well-defined meaningful technical problems. The second point is that only problems which meet the basic criteria outlined earlier can be accepted, due to constraints imposed both by limited manpower and by the basic purpose of the effort--which is to apply aerospace-related technology to solutions of significant problems impeding progress in biomedicine.

THE NEXT STEPS

The problem-solving approach used by the Biomedical Applications Teams embodies a problem definition-solution search methodology which:

- Provides access to NASA scientific and engineering expertise,
- Focuses multidisciplinary expertise on discrete, technological problems, and
- Facilitates innovative secordary applications of aerospace-related technology.

Basically, the methodology employed is to carefully define important biomedical problems for which it appears relevant aerospace technology may exist and then systematically search both computerized aerospace data files and NASA's field installations and research centers for potential solutions.

After an item, or groups of items, of aerospace technology has been identified as potentially useful, the team collects the maximum information available. This could involve retrieving pertinent information or obtaining hardware or models for evaluation if such is indicated and feasible. The team then makes a preliminary evaluation to determine whether the item or information, either in present or modified form is applicable to the current problem. Items that survive this preliminary evaluation are then transmitted to the researcher or practitioner who posed the original problem for a more thorough trial in laboratory and clinic. Often, the problem originator's evaluation will indicate that some modification or adaptation is needed to make an item suitable for biomedical application. The adaptation required may range from minor change to a substantial development effort. The evaluation and adaptation stages of the technology applications process are closely interrelated, and, frequently, a number of evaluation-adaptation-evaluation cycles are needed to establish the medical value of an item of aerospace technology.

TECHNOLOGY APPLICATIONS--THE PROGRAM'S GOAL

An application of technology--that is, utilization of aerospace technology for purposes other than that for which it was intended--represents the ultimate aim of the Biomedical Applications Teams' efforts. Technology applications are of singular importance in the continuing NASA effort to ensure, for the public sector, the greatest possible return for dollars invested in the space effort. When a technology application has been accomplished, the problem originator is asked to aid in documenting it so that the information can be distributed to others who might benefit from the technology application. This could involve the participating researcher or practitioner preparing papers

for presentation at medical meetings and for publication in medical journals. In addition to this means of disseminating information pertaining to the new application of technology, NASA frequently makes such information available to equipment manufacturers through seminars, written reports, and personal contacts--as a means of encouraging industry to assume the responsibility for making the innovations resulting from the technology application program available to the entire biomedical community.

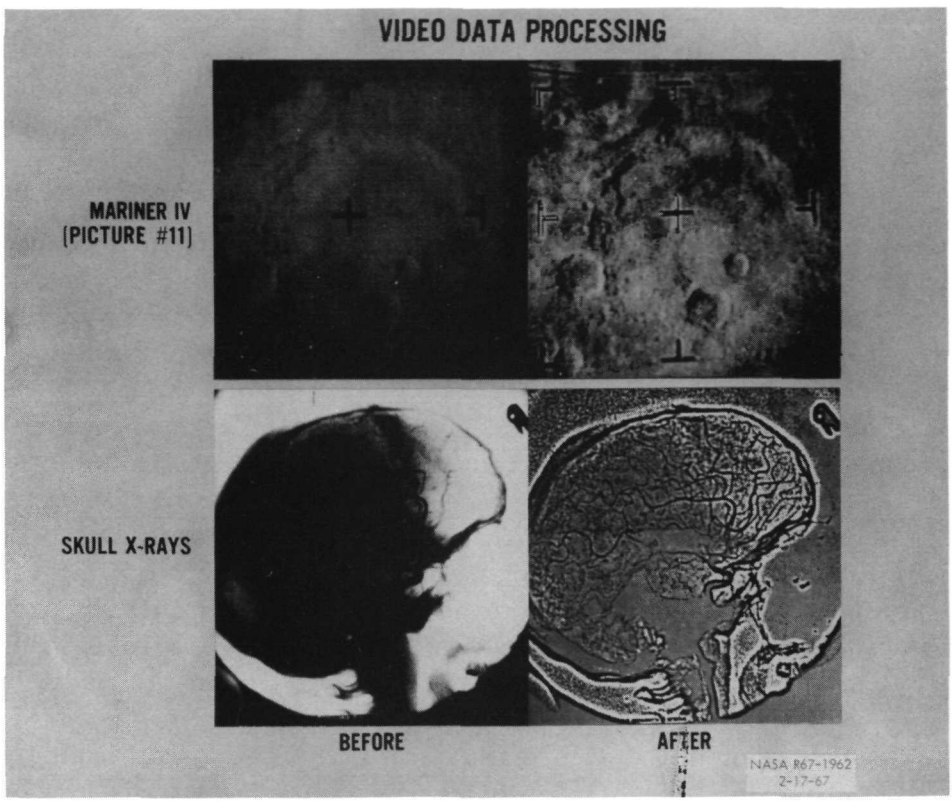


Figure 5. An Example of Aerospace technology developed for one purpose--image enhancement of photographs from outer space, -- applied to solve a biomedical problem -- improved resolution of X-rays for medical diagnosis.

II. SOUTHWEST RESEARCH INSTITUTE BIOMEDICAL APPLICATION TEAM ACCOMPLISHMENTS

Applications of Technology Accomplished

During the period covered by this report, the SwRI Biomedical Applications Team was able to achieve a number of significant applications of aerospace technology. The problems solved and a description of the technology, which facilitated their solution are outlined in the following problem summaries.

PROBLEM OVA-5 Nonencumbering EEG Electrode Assembly. Suitable For Long Term Sleep Research Applications

The investigator is conducting a large-scale research program funded by the National Science Foundation designed to assess long-term psychophysiological responses of humans subjected to extreme, exotic and stressful environmental conditions such as one encounters at the Amundsen-Scott Station, Antartica. An important phase of the research involves collection and analysis of the psychophysiological concomitants of sleep (as a definitive state of consciousness). This is expected to permit construction of an overall picture of the general processes of adaptation and disadaptation to extreme environmental conditions, from a psychophysiological viewpoint. Available evidence suggests that individuals exposed to the Antartic environment show a dramatic dropout of state 4 sleep. This suggests the existence of some "bridges" linking physiological changes with subtle behavioral changes of the organism and vice versa, which may lend themselves to objective recording and measurement.

Objective recording and measurement of the sleep data has been made possible by modification of an electronic sleep analyzer developed for the NASA Sky Lab program (Tech Brief 70-10110). However, a suitable electrode assembly, suitable for use during extended periods of sleep was not available to the investigator. The EEG helmet system developed under the Biomedical Applications Program for use in conjunction with EEG audiometry was unsuitable for use in the present case because it could not be worn comfortably during long periods of sleep and involved artifacts caused by the substantial amount of movement associated with the sleep state. A nonencumbering assembly was needed which (1) was comfortable, (2) did not require adjustment during long periods of use, and (3) resisted artifacts caused by sleep associated movement. Interaction with scientists at the Manned Spacecraft Center's Neurophysiology Laboratory resulted in provision of a prototype EEG electrode assembly developed in the form of a soft cap, which met the problem originator's needs. Availability of the

soft cap assembly is expected to facilitate acquisition of the researcher's sleep data. Additionally, the assembly will be evaluated as a possible alternative to the more expensive"hard" helmet used in the EEG audiometric system perfected at MSFC.

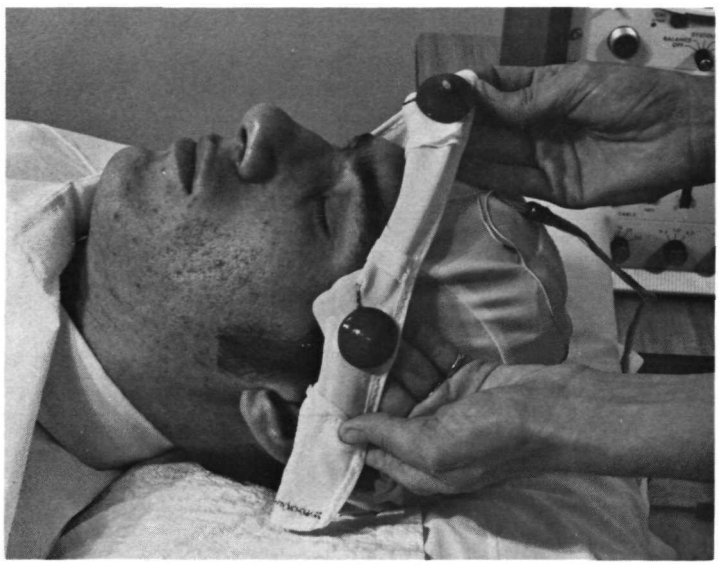


Figure 6. The prototype MSC soft cap EEG electrode assembly

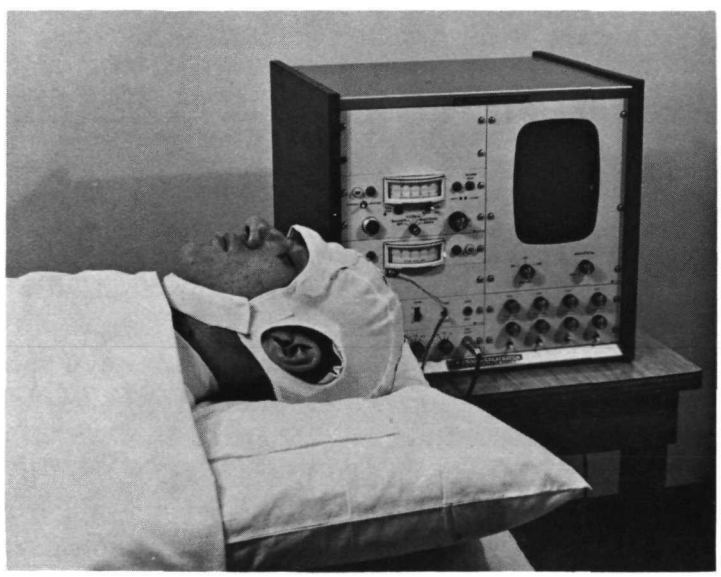


Figure 7. The MSC soft cap EEG electrode assembly can be used for extended periods without disturbing normal sleep and is resistant to motion artifacts

PROBLEM UAM-11 Ultra-Low Frequency Bandpass Amplifier for Gastro-intestinal Electric Potentials

Electrical potentials generated by living organisms have long intrigued medical researchers, since unique electrical depolorization patterns are indicators of organ function and dysfunction. The widespread use of electrocardiograms, electroencephalograms, and electromyograms provided examples of the valuable application of biological electrical potential phenomena to clinical medicine. There is reason to believe that electrical potentials generated by the smooth musculature of the gastro-intestinal tract can be equally useful. Researchers at a southeastern medical school are engaged in a large-scale research program designed to investigate possible correlations between various gastro-intestinal disease states and electrical potential phenomena centered in the gastro-intestinal tract. To date, such potentials have been related clinically to such states as hypothyrodism, hyperthyrodism, and level of morphine ingestion.

Research in this area has been hampered by the nonavailability of a suitable, economical ultra-low frequency bandpass amplifier. Commercially available instruments, having a much more than needed range in filtering and gain, tend to be very costly. A device which provided appropriate signal conditioning in the specific area of interest was needed.

A search of the NASA data bank revealed that NASA's Ames Research Center had developed a tunable bandpass filter with variable selectivity (Tech Brief 69-10130). Basic circuits were obtained from NASA/Ames, along with authorization from TAD to fabricate the filter on an in-house applications engineering basis. This resulted in provision of a stable, active RC bandpass filter having continuously variable, noninteracting control of center frequency, Q, and center frequency gain, which was capable of providing reliable signal conditioning in the investigator's specific area of interest.

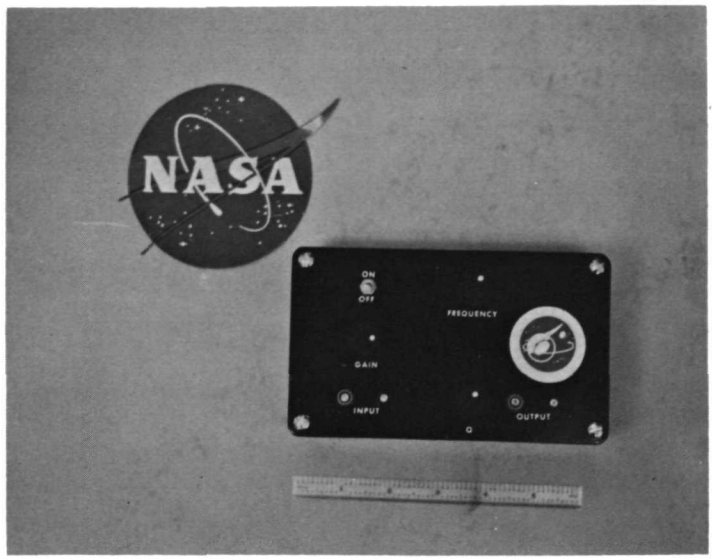


Figure 8. Ultra-low frequency bandpass amplifier developed for use in detecting gastrointestinal potentials

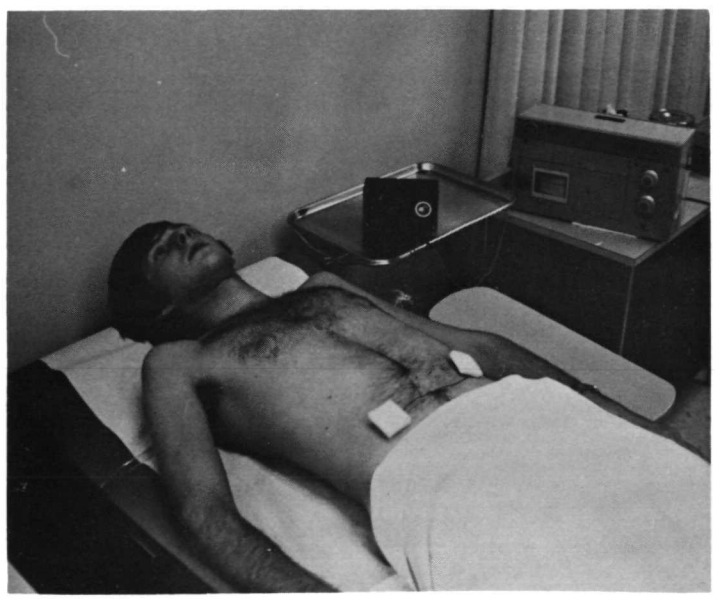


Figure 9. The NASA-developed gastrointestinal electric potential amplifier in use

PROBLEM UAM-8 Electrical Safety Standards for Hospitals

Hospital patient safety (especially during screening an monitoring procedures involving electrical equipment) is causing increasing concern in the Congress and various journals and magazines. It has been estimated that, on the average, three people are killed daily in hospitals as a result of faulty equipment. An example of how such an event can occur with equipment involving electrodes which make contact with a patient is diagrammed below.

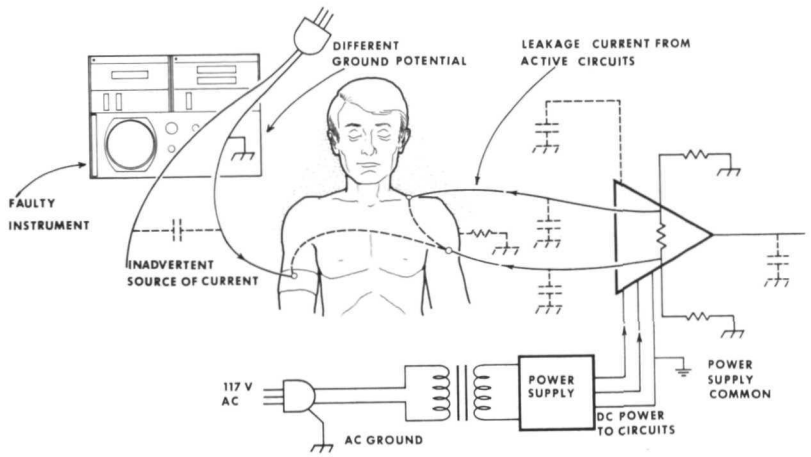


Figure 10. Possible Dangerous Currents in Patient Monitoring Systems

Research has shown that an excellent means for isolating the patient from the hazards described above can be obtained through optical coupling techniques. However, up to this point in time, such techniques have not been economically feasible--to the extent that manufacturers of medical instrumentation have been willing to incorporate them into their equipment designs.

An EKG isolator concept, developed at Marshall Space Flight Center, using optical coupling techniques was modified by the SwRI Biomedical Applications Team to provide an effective solution for the need to be able to monitor a patient's condition without exposing him to possible severe, and potentially fatal, electric shock. The NASA invention, for which a patent application has been filed, uses a light beam to transmit the biopotential signal from the electrodes on the patient to the medical instrumentation. A prototype optical coupler was built into the patient vital signs monitor (CMR-3). In this approach,

conventional EKG electrodes for connecting the patient to the vital signs monitor input are used. The EKG signals are then amplified and fed into the EKG isolator, which converts the signal from an electrical impulse to a light beam, using a light emission diode. The signal is relayed by way of the light beam from the diode to a photo transistor in the output portion of the isolator and subsequently to the vital signs monitor. This system provides complete isolation between the patient and the instrumentation, thereby precluding hazards such as those described above. Application to a variety of uses in rehabilitation is anticipated, such as electromyography, electroencephalography, and other patient monitoring procedures.

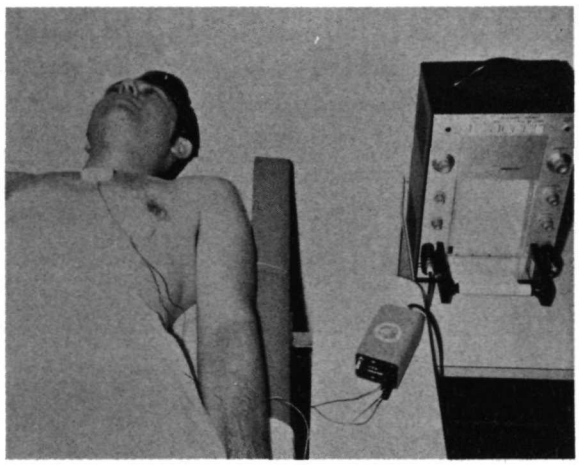


Figure 11. The Optical Isolator In Use

PROBLEM HSR-7 Improved Control Mechanism to Expand Self-Sufficiency of Quadriplegics

Patients who are paralyzed in all four limbs (quadriplegics) and multiple amputee patients are almost totally dependent upon support from patient care personnel for any activities or interests in which they can participate. The morale of such patients is markedly improved and the demands on patient care personnel are greatly relieved by any device or procedure which generates self-sufficiency capabilities. The extreme limitations of the quadriplegic and the shortage of patient care personnel have become significant medical problems.

The problem originator had evaluated the self-sufficiency potentials for the NASA-developed eye switch. That technology application benefitted the situation, but it also introduced irritations of the eyes when the light was exposed to the cornea for extended time periods. Some patients felt encum-

bered because they had to wear the eyeglass frames up to 24 hours each day. Some disorientations were encountered when they repeatedly looked away from what they were doing to actuate the eye switch. The glass frames tended to obstruct their already limited viewing area. The problem originator sought an alternate means to replace the eye switch, still within the capabilities of these patients to operate them.

Some of the quadriplegics are able to make limited head and neck turns to either side. Some were able to control the movement of a finger or a toe. Most of them could produce a directed puff of air. These factors were carefully considered and applied to the search for an alternate system.

The Southwest Research Institute NASA Biomedical Applications Team interacted with scientists and engineers at NASA Langley Research Center. One of the engineers proposed and outlined a complete control system which could be actuated by a puff of air directed against a paddle to contact a microswitch.

NASA Langley Research Center coordination was provided through Mr. John Samos for Mr. Charles Nichols and his staff of engineers to work with a Southwest Research Institute technician and design a breadboard model for a prototype system, breath-actuated microswitch.

The original prototype system was produced and has been modified to expand the capabilities to accept input from a variety of actuating sources. It will respond to the eye switch, a breath-puff switch, a toe or finger switch, and a pneumatic pressure switch which the patient can actuate by slightly turning his head. Additional circuitry was built into the electronic control box to permit the patient to selectively activate any one of four electrically operated appliances.

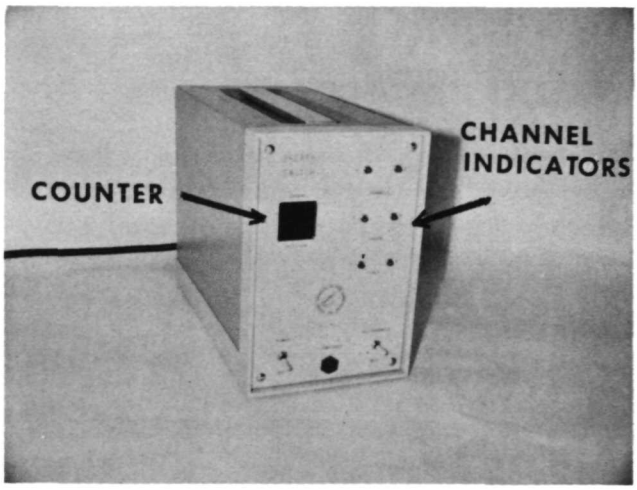


Figure 12. Logic unit for the automated patient environmental control unit. The channel indicators light up when a given channel is activated, permitting the patient to know at any given instant which channels are activated. The counter (or digital display unit) permits the patient to follow the channel selection sequence so that he knows precisely what channel he is on at any given time during the channel selection operation.

Figure 13. Rear view of the logic unit showing the outlets where patient assist/ comfort items are plugged in (such as lights, radios, television, page turner, electric bed adjustor, etc. Each outlet corresponds to a particular channel on the logic unit.

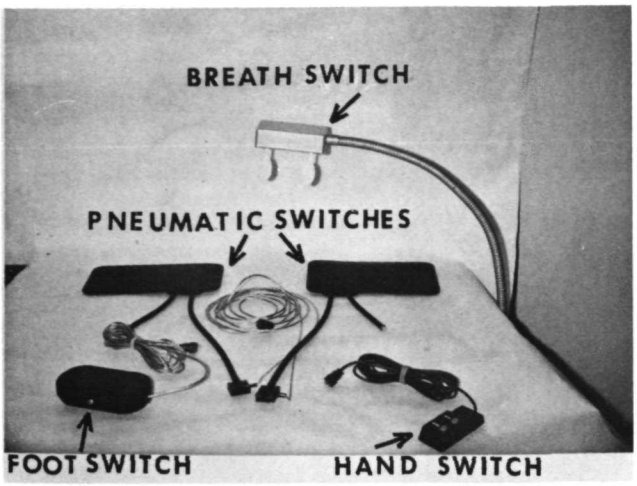


Figure 14. Various types of switches available for use with the logic unit. Not shown is the NASA-developed eye switch, which can also be used. The pneumatic switches are placed adjacent to the patient's head. A slight pressure activates the logic unit. One switch functions as a channel selector; the other functions to turn the channel on or off.

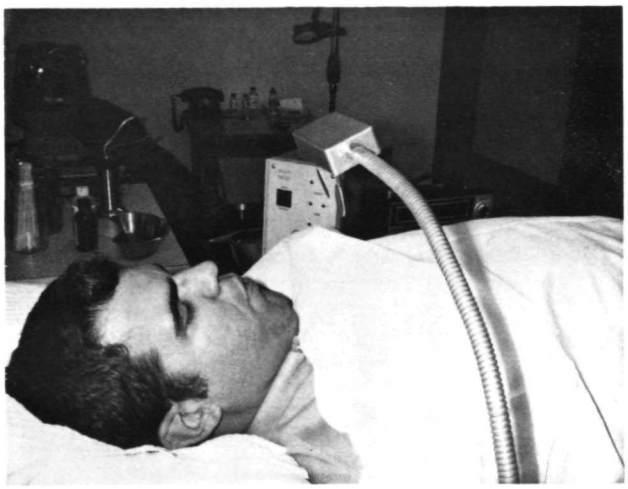


Figure 15. The automated patient environmental control unit in use with the breath actuated switch. The innovation permits totally paralyzed patients to control assist/comfort devices merely by gently blowing on the breath-actuated switch. For the lesser disabled patients, other types of control mechanisms (see illustration to the left) can be utilized as inputs into the logic unit.

Extensive engineer testing has proven the feasibility and operational capacity for each of the alternative actuating control devices, and the coupling to selectively control the activating switches, within the capabilities of the patients who would use them. The original prototype model is being shipped to the Huntsville Alabama Hospital for use with their patients and extensive applications in the special room set aside by the hospital for NASA extended facilities employing aerospace technology. The complete specifications, including wiring and diagrams, are being provided to the Hot Springs Rehabilitation Center, Hot Springs, Arkansas, for their use in fabricating any additional models they may require.

These improved control mechanisms to expand self-sufficiency for the quadriplegic and pultiple amputee patients, are expected to significantly contribute to solutions of important medical problems.

PROBLEM RRC-Z Accurate Cardiac Telemetry from Active Subjects

Important advances have been made in medical care, treatment and management of heart disease patients in the past several years. Increased attention has been directed to the medical problems associated with heart disease as a result of the upsurge in the numbers of individuals found to have heart disease and in the numbers of deaths known to have resulted from heart complications.

Rehabilitation regimens are prescribed for patients who are convalescing from a coronary episode or from associated surgery. It is necessary to individually tailor the exercises for each patient so that adequate demands are placed on the proper muscles without inciting another episode. The patients have usually been conditioned into inactivity during early recovery phases to avoid additional myocardial strain. Psychological and physiological rehabilitation is directed toward restoration of a healthy myocardium and attitude.

The problem originator sought to be able to obtain information concerning heart rate and the electrocardiogram waveforms from his exercising patients. He had been unable to obtain sufficiently sensitive S-T waveform information from commercially available electrocardiogram monitors for the significant S-T depressions relating to reactions of the patient to his exercise.

Relevant NASA technology was located in NASA Technical Brief 64-10171 "Subminiature Biotelemetry Unit Permits Remote Physiological Investigation" which described components essential to the problem. Certain minor reengineering modifications were made to fabricate a signal transmitter and a demodulator. These innovations have been coupled to existing monitor devices in the problems originator's hospital and have completely satisfied the problem originator's immediate needs.

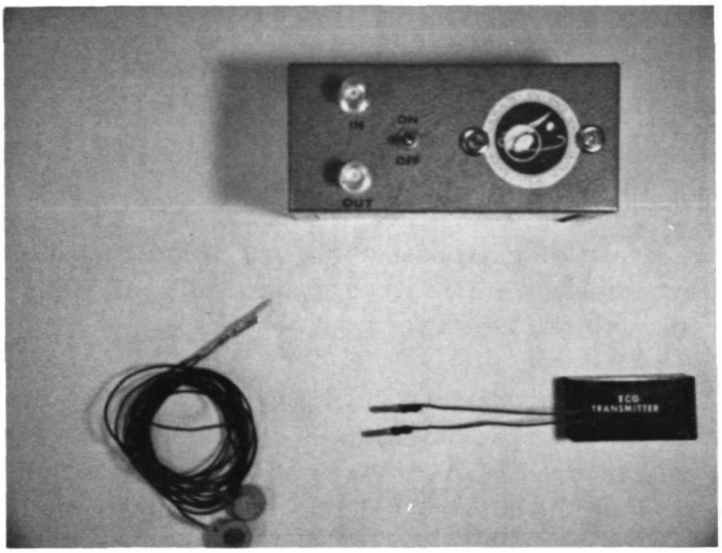


Figure 16. Cardiac Telemetry Instrumentation

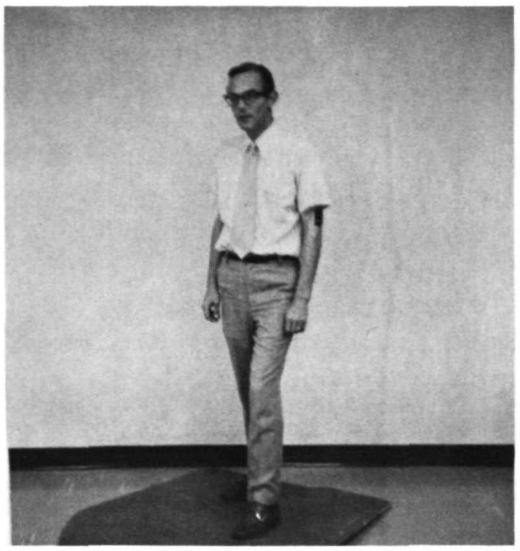


Figure 17. Exercising Cardiac Patient with EKG Transmitter Attached to Upper Arm

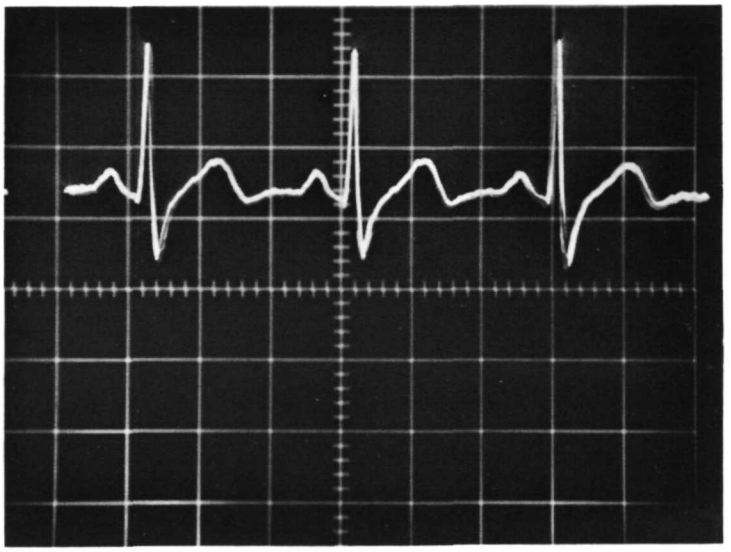


Figure 18. S-T Waveforem From Exercising Patient

PROBLEM GLM-35 Beta Radiation Catheter Probe for Measuring Cerebral Blood Flow

Irreversible brain damage quickly can occur when blood flow is stopped or grossly restricted to the head area. For this reason, it is essential to monitor blood flow to the brain of patients who have sustained head injuries. Also, blood flow measurement is an effective means of evaluating the patient's recovery and response to specific therapeutic procedures.

Researchers at the University of Texas Medical Branch head injury research center are using an isotope (Krypton-85) as a means of measuring cerebral blood flow. Head-injured patients are administered the isotope (by breathing) and arterio-venous concentrations are measured. Comparison of isotope levels entering the brain (via the carotid artery) with the concentration in the blood leaving the brain (via the jugular vein) provides accurate estimates of blood flow through the brain. The difficulty is that with the technique repeated blood samples have to be withdrawn to obtain the required comparisons, a procedure which involved great discomfort and potential danger of infection to the patient. With the technique few data points are made available for assessment. An alternative means was badly needed for monitoring cerebral blood flow.

A search of the NASA data bank revealed that a NASA Contractor (Solid State Radiations, Inc.) had developed a biomedical radiation detecting probe which was sensitive enough to detect the isotope used. The device is described in detail in the attached patent (#3,427,454) issued to NASA on February 11, 1969. The radiation probe described, being small enough to incorporate within an intravascular catheter, presented the way to a technique capable of continuously monitoring cerebral blood flow. That is, a catheter mounted probe could be inserted in the carotid artery and jugular vein and left in place - in contrast to the existing method of sequential vascular punctures to withdraw blood samples for analysis.

Accordingly, the problem was nominated as an applications engineering candidate and approval obtained to mount several of the detectors in an appropriate intravascular catheter (#7 French), along with an ultra-miniature preamplifier fabricated at Langley Research Center (see figures 19and 20 below).

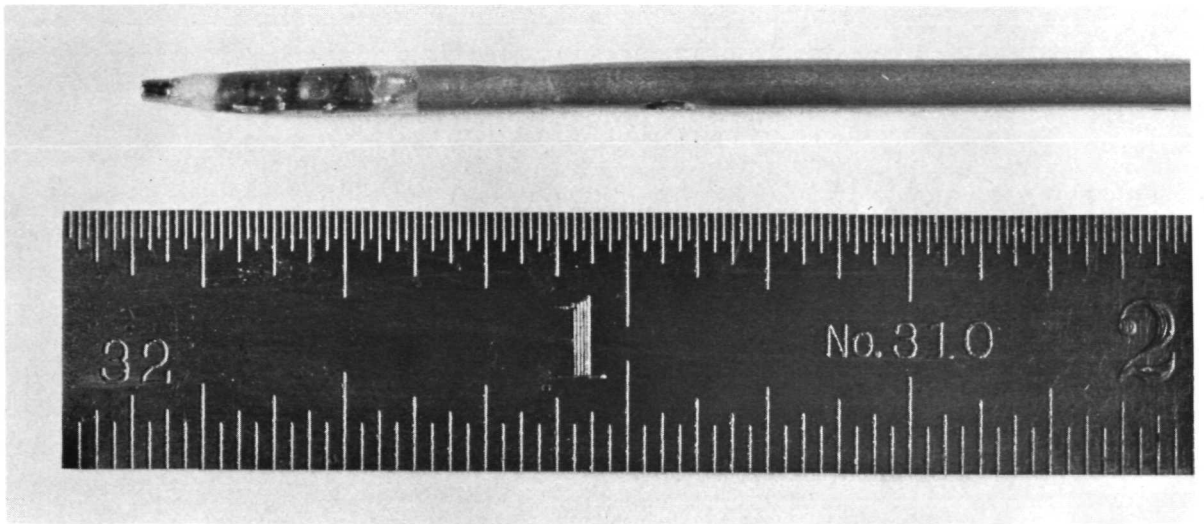


Figure 19. The biomedical radiation detecting probe mounted in a #7 French intravascular catheter ready for use

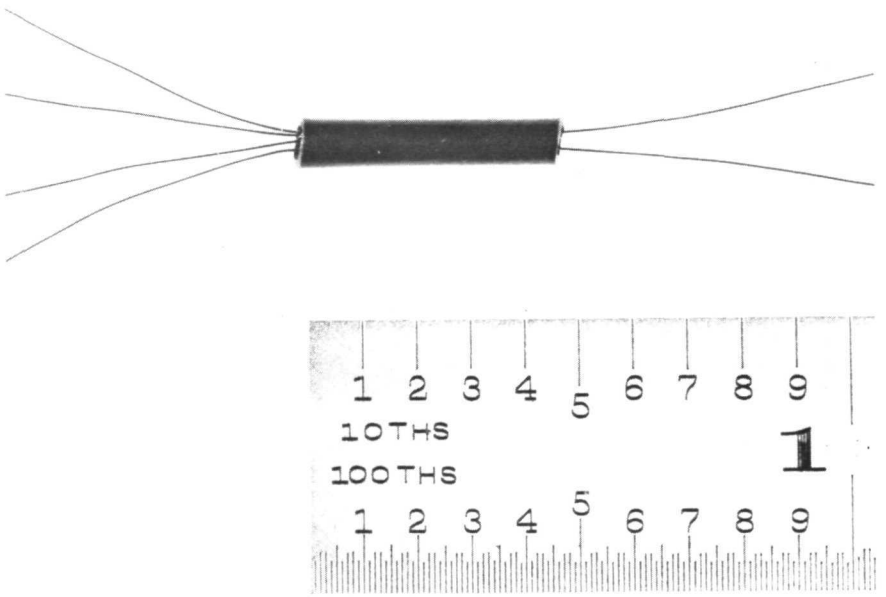


Figure 20. The ultraminiature preamplifier fabricated for use with the detector at Langley Research Center

Following are results obtained during in vivo testing of the detector system.

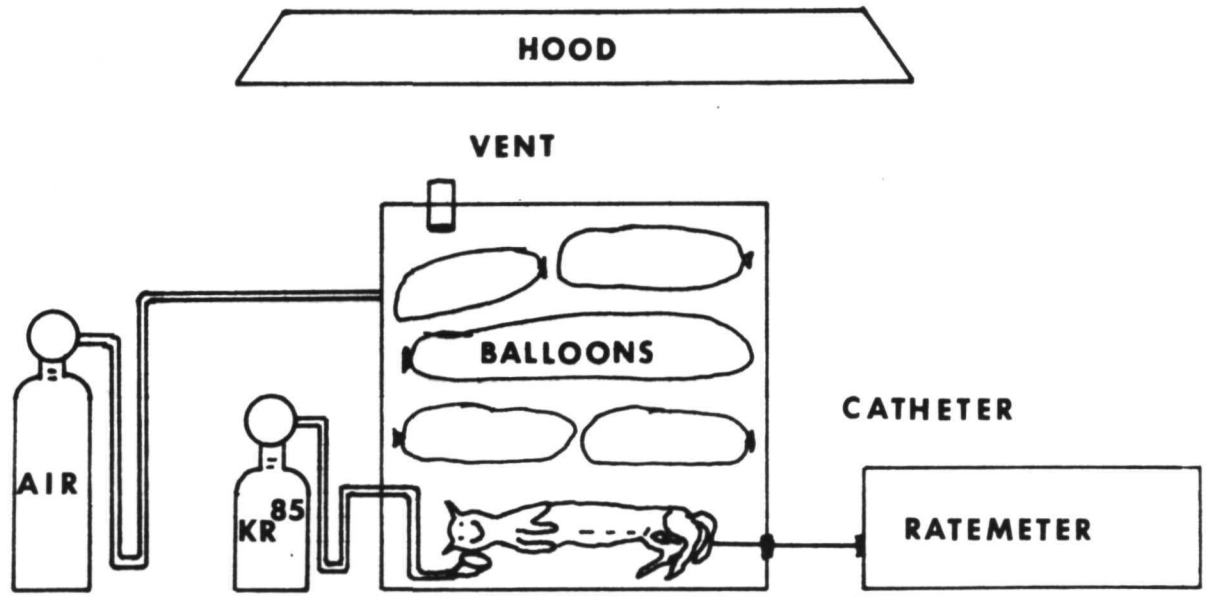
Preparation

Dog - "Scott" - 14 lb. male

First cutdown on femoral artery unsuccessful. Artery too small for dog catheterization.

Second cutdown posterior to renal veins. Catheter inserted into vena cava.

Dog placed in chamber and instrumentation connected as shown below.



*Balloons used to cut down volume of chamber.

Fig. 21. Experimental arrangement for testing radiation probe

It is expected that this use of the NASA-developed solid state probes to measure Kryton-85 concentration will vastly improve present methodology for monitoring cerebral blood flow. This in turn will permit more precise evaluation of the extent of head injuries, progress towards recovery, and the effectiveness of various forms of therapeutic treatment.

In Situ Test #1

Background Counts

GM Counter α, β, γ	75 cpm
Catheter in Place	10 cpm
Catheter in Dog	10 cpm

Application of Krypton

Time (Min)	Counts CPM	Count Var	Notes
3:28	T_c 10 sec		Kr^{85} on
3:29			Resp Rate 9 b/m
3:32			300 cc Kr^{85} injected
3:34	100	N/A	
3:35	150		Saturation
3:36	120	long T_c	Flush chamber @ 5L air/min
3:37	100		Resp Rate 10 b/m
3:41	50		
3:43	70		
3:56	20		Flush Off
3:59	10		
	T_c 30 sec		
4:03	10		Kr^{85} on
4:05			Resp Rate 9 b/m
4:09	65	N/A	Resp Irregular
4:17	50		
4:19	50		Flush @ 5L air/min
			Exhaust (4k cpm)
		long T_c	
4:39	10		Flush Off
4:50			Dog Sacrificed

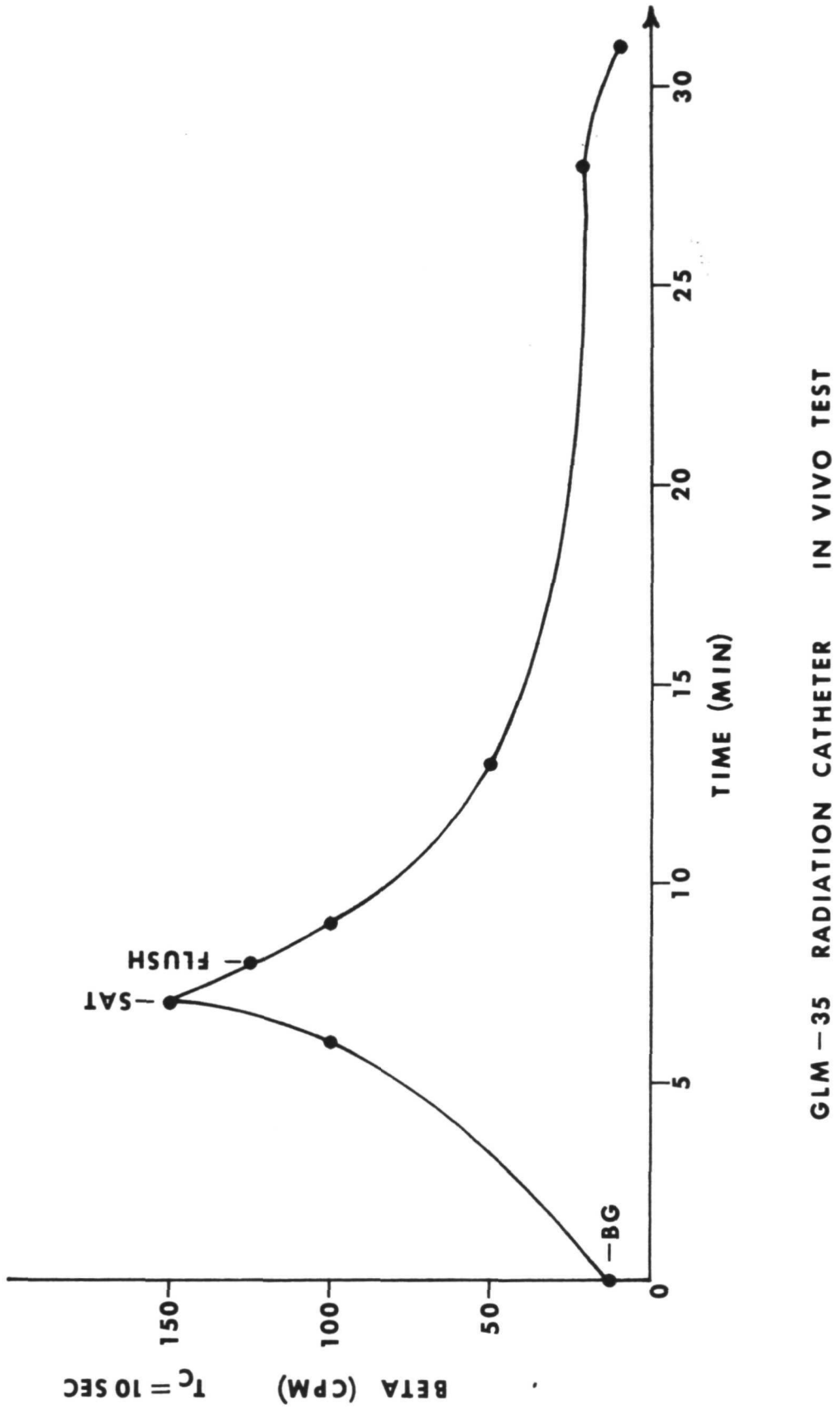


Figure 22. In vivo test Results for Radiation Detector Probe

PROBLEM UTM-37 Tendon Repair Device

When tendons are severed by accidents and injuries, surgical restorations are required to restore mobility. Wire and other durable suturing materials have been employed to bind the tendon ends in close proximity to permit healing to anatomically join them again. However, these procedures required followup surgery in many instances for the purpose of exposing and removing the suture materials following the healing. Cosmetic and plastic surgery frequently was necessary to repair the area as a result of the scarring.

The problem originator sought the means to butt-weld barbs along the shaft of a fine gauge wire so that it could be inserted as a pin into both of the cut ends of the severed tendon. His idea was to so angle and place the barbs that they would present minimum resistance by flexing down against the shaft as the pin is inserted. Any outward pull by either of the severed ends would cause the barbs to catch into the tendon material, firmly joining the ends together for healing. This pin could then remain in place after healing since it would resist any tendency to migrate in the tissue and would present no biocompatibility problems.

The problem originator was made aware of the methodology described in NASA Tech Brief 70-10136 "Butt Welder for Fine Gauge Wire" and was satisfied that this could be the answer to his placement of barbs on the fine wire pins. Researchers at NASA Langley Research Center expressed willingness to work with the problem originator in design and fabrication of prototype models. Interaction between these parties resulted in provision of a number of prototype tendon repair devices and establishment of the feasibility of quantity production, using the NASA-developed butt welder for fine wires. The tendon repair device in finished form is shown in Figure 23.

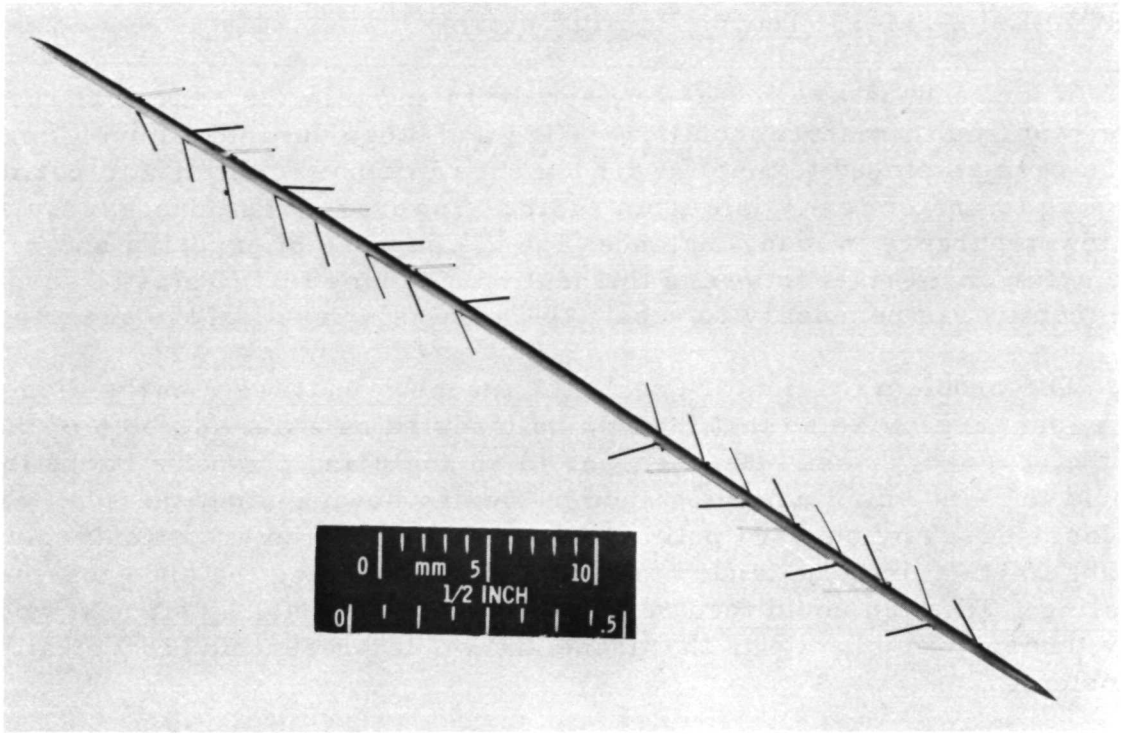


Figure 23. Butt-Welded Tendon Repair Aid developed at Langley Research Center. The aid can be fabricated from a variety of biocompatible metals

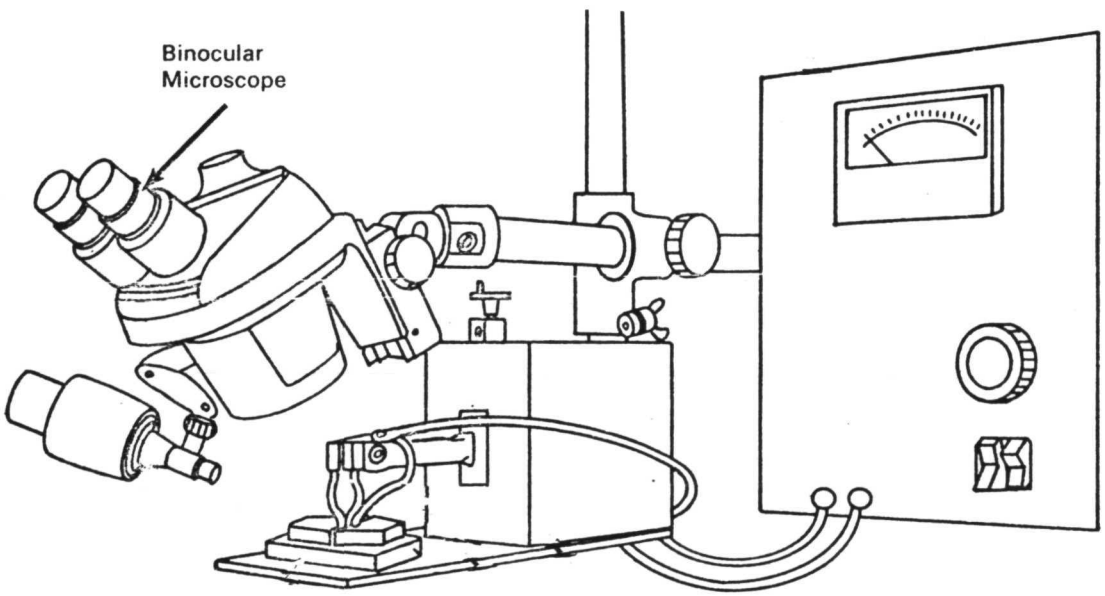


Figure 24. The Butt-Welder for Fine Gauge Wire apparatus developed at Langley Research Center

PROBLEM TCB-7 Portable Light Detector System for the Blind

Though lights are of no value for the blind, they are used nevertheless, particularly when the blind individual is being visited by those individuals who have use of their sight. Knowing when lights are on or off presents a problem for the blind--particularly in the case of ceiling lights which cannot be touched to feel the heat associated with an illuminated light bulb. Lights unnecessarily left on are not only wasteful but are safety hazards and tend to alarm neighbors who sense something may be wrong when left on at night. In addition, it is important for the blind person to be able to know when lights are illuminated in areas presenting safety hazards to visitors--such as stairways during the hours of darkness. A southwest rehabilitation center requested NASA assistance in developing a small hand-held device which would activate an acoustic signal when it was pointed towards a source emitting light. A search of the NASA data bank revealed technology directly applicable to the problem.

Useful methodology and circuitry were located in the following NASA Tech Brief: 68-10315, 68-10502, 68-10521 and 70-10401. Additional assistance was gained from NASA SP-5046.

Several prototypes were fabricated and delivered for evaluation. Evaluation reports indicate that the device performed satisfactorily except on lighted telephone buttons. A second model was fabricated to include use with telephones without affecting its utility in the other areas.

Statements from blind users indicate that this is a valuable tool in the determination of lighting conditions and is convenient to carry on their person.

Figure 25. Portable Light Detection System developed under NASA's Biomedical Application Program using aerospace technology.

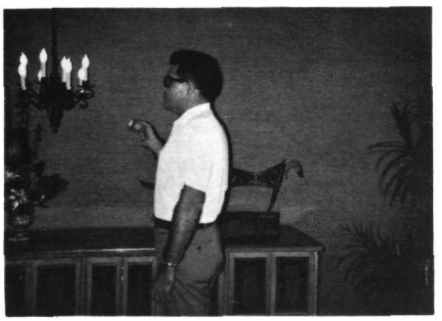


Figure 26. The Detector, when pointed toward a source of illumination, emits an audible signal.

Figure 27. The Light Detector can indicate to the blind, by an audible signal, whether it is daylight or dark.

Figure 28. The Detector can also indicate when automatic cooking devices (coffee pot with pilot light) have completed a cycle.

PROBLEM TCD-1 Portable Sound Meter for Use by Deaf Persons

The person with normal hearing has little difficulty with the values of ambient sound and the amplitude of his own voice output in learning to speak, because they are automatically assessed by his hearing abilities. The deaf person can be taught to effectively speak, although unusual difficulties are encountered because they cannot realistically gauge the levels of sound. They have no way to estimate the noise level in any surroundings and can only estimate the acceptable level of their own speech amplitude by observing reactions of persons in that vicinity. Deaf persons are very sensitive about offending others with extraordinarily loud or unusual speech sounds, and they encounter many psychological problems when it is necessary to talk with others in public or in private. The problems are severe when teaching the deaf person to speak and exist in interrelations for the rest of a lifetime. Deaf persons need a simple and portable means for assessing amplitudes of sound. A solution to this problem was proposed by Mr. Clyde Pittman, an engineer at Kennedy Space Center. Mr. Pittman's solution involved a battery-operated device containing a microphone, amplifier, potentiometer, and meter.

The problem was nominated as an applications engineering candidate and a prototype unit developed by the SwRI Biomedical Applications Team. By observing the meter (Figure 29-30) as he speaks, the deaf person can maintain his voice within calibrated ranges.

Figure 29. The portable sound meter for the deaf contrasted with a conventional sound meter

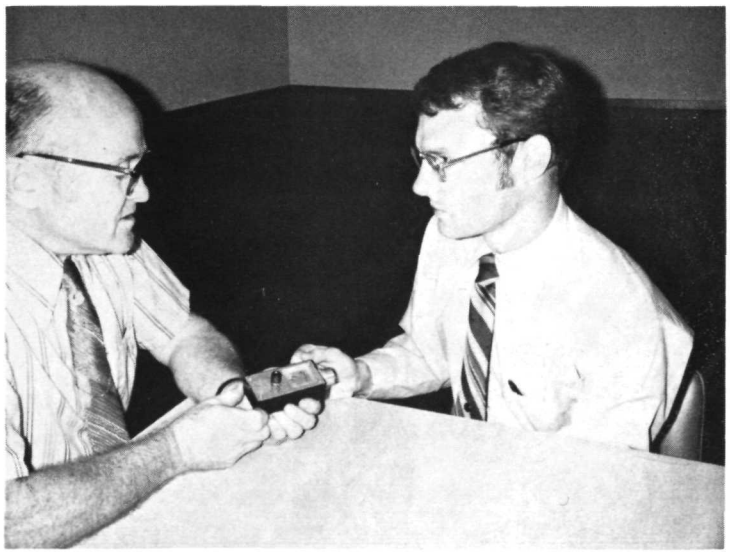


Figure 30. By observing the meter face as he speaks, the deaf person can maintain his voice at a level commensurate with his surroundings

PROBLEM TCB-1 Remotely Activated Switch for use By the Blind to Activate Power Tools

DISCUSSION OF PROBLEM AND REASON FOR POTENTIAL TECHNOLOGY APPLICATION CLASSIFICATION:

It has been demonstrated that, as part of a rehabilitation program, blind persons can be trained to operate power tools--even table or bench saws--thereby enhancing their self-sufficiency. They can use their sense of touch to orient the material that they are to work with (with respect to the particular power tool). However, they tend to lose the positional orientation when they have to move the hand to manually turn on the activating switch.

The Commission for the Blind requested NASA assistance in developing a switch -actuating device controlled by body movement other than that associated with the extremities, so as to not adversely affect balance or orientation. This is in consideration of the dangers inherent in being in close proximity to power tools.

Analysis of various switches used by NASA for hands-free control led the SwRI BATeam to conclude that the eye switch held considerable potential for the purpose outlined above. In this connection, even though the blind person does not see, he can move his eyes, thus permitting the change in reflectivity of the eyeball's surface to be used as a switching mechanism.

Figure 31. Eye switch being used by a blind person to activate a power tool

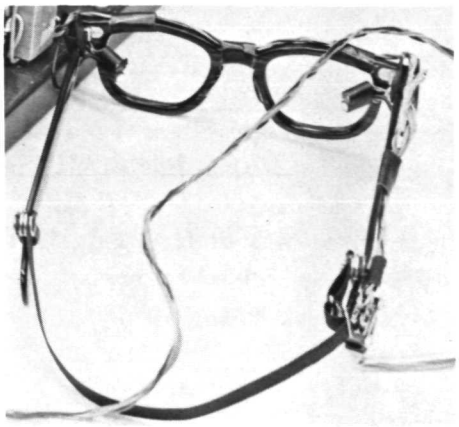


Figure 32. Closeup of the NASA eye switch

PROBLEM TCD-2 Warning System for the Deaf

Many deaf and hard of hearing persons have lost their lives in hotel, motel and private residence fires simply because they could not be alerted in the normal manner, such as: ringing the door bell, pounding on the door, shouting, or ringing the telephone. The problem is particularly severe in cases where access into a room is impeded by various types of bolts and chains, rendering a pass key or duplicate key useless.

The Texas Commission for the Deaf requested NASA assistance in developing a simple, economical device which could be used in a convenient manner to signal the deaf person (whether awake or asleep) that someone was attempting to gain his attention via pounding or knocking on the door, ringing the door bell, or ringing the telephone. A portable device was desired which did not require rewiring or modification of the premises and which could be moved readily from one location to another (as from one hotel room to another during travel).

A problem statement describing the requirement was circulated to the various NASA research centers. While a number of suggestions were received, the most promising was submitted by Mr. Clyde Pittman, Design Engineering Directorate, John F. Kennedy Space Center. The resulting system makes use of an accelerometer much like the one used in aerospace applications for detection of micrometeorites. Activation of the accelerometer, which is affixed via suction to a door surface or telephone, causes a switching mechanism to function which either (1) activates a vibrator placed under the pillow, if the deaf or hard of hearing person is sleeping, or (2) activates a light which flashes intermittently, much like a strobe, to get the awake deaf or hard of hearing individual's attention. The switching mechanism is battery powered, with the vibrator and flashing light components being powered by AC current

obtained from any convenient electric outlet. The device is capable of receiving multiple inputs (for example, one accelerometer affixed to the telephone and one to the doorbell). It is possible to have several visual signals present, such as a red flashing light to indicate ringing of the telephone and green to indicate knocking at the door or ringing of the door bell, etc.

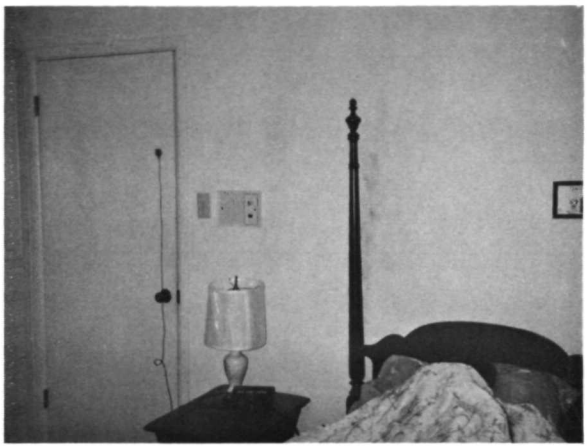


Figure 33. System connected to door alarm for nighttime use

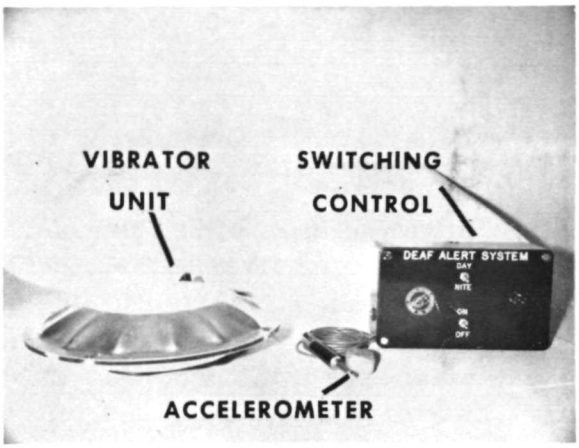


Figure 34. Closeup of alarm system components

Figure 35. Use of the alarm system to pick up ringing door bell or knocking at the door

Figure 36. Use of the alarm system to indicate ringing of the telephone

Availability of the eonomical alarm device, which can be moved readily from location to location, promises to provice increased safety and peace of mind for the deaf and hard of hearing individual.

PROBLEM TCB-16 New Type of Tracking Cane for the Blind

Blind individuals do not have at their disposal an economical cane which can be used by them to "track" a previously laid out course, as a means of providing a greater measure of self-sufficiency. The more sophisticated canes developed as aids to the blind (laser canes, ultrasonic devices, etc.)are not within the economic reach of the typical visually handicapped individual. A more economical, but effective alternative is needed, particularly for use in rehabilitation centers, homes for the blind, etc., where the number of blind persons present makes it worthwhile to lay out a guidance track. A flash sheet prepared at MSFC (ATTS-TU MSFC October 9, 1970) describes a new type of cane for tracking. This concept involved a groove track which was not very practical to lay down due to cost. However, by adapting the MSFC cane to include the optical sensor used at the NASA sight switch, it is possible to have an effective tracking-sensing system which meets the needs described above. Use of the optical system permits track to be laid down quite readily with paint, a durable adhesive tape, inlaid tile, or conventional carpet. The system allows incorporation of coded information such as right or left turn, stairs ahead, or other hazards, so as to permit the visually handicapped person to negotiate the track with greater speed and assurance. The system has undergone successful tests in the laboratory, prior to the delivery to the problem originator.

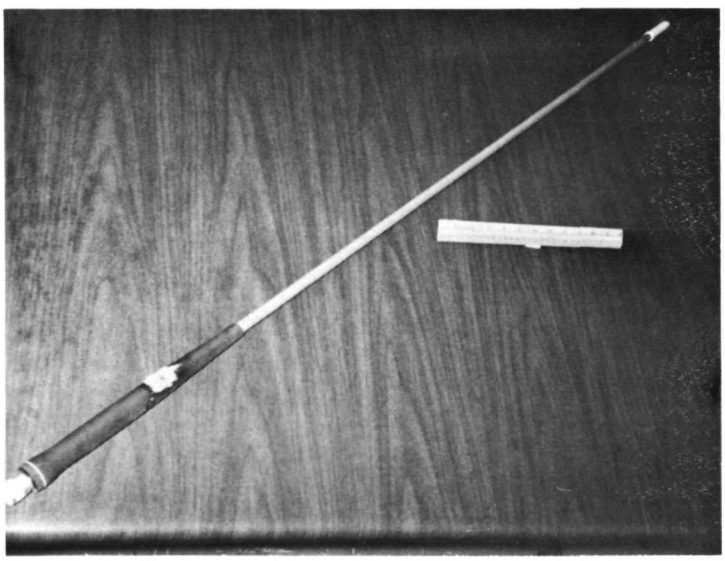


Figure 37. The optical tracking cane, showing primary components

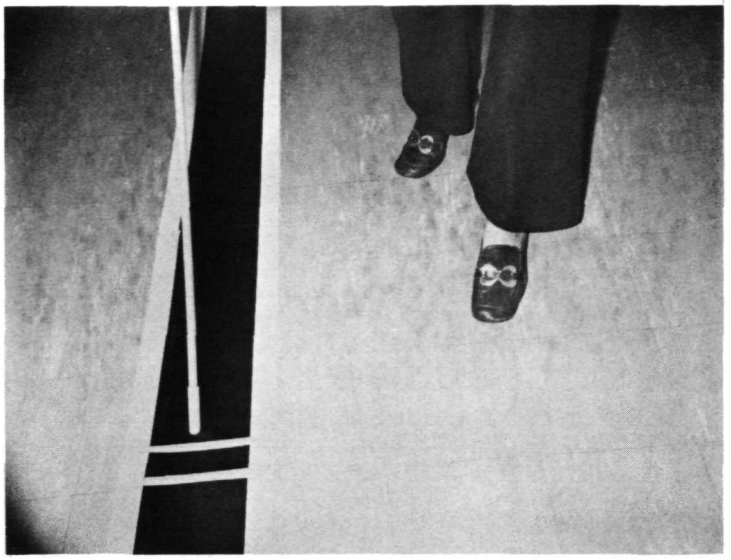


Figure 38. The cane in use on a simulated track

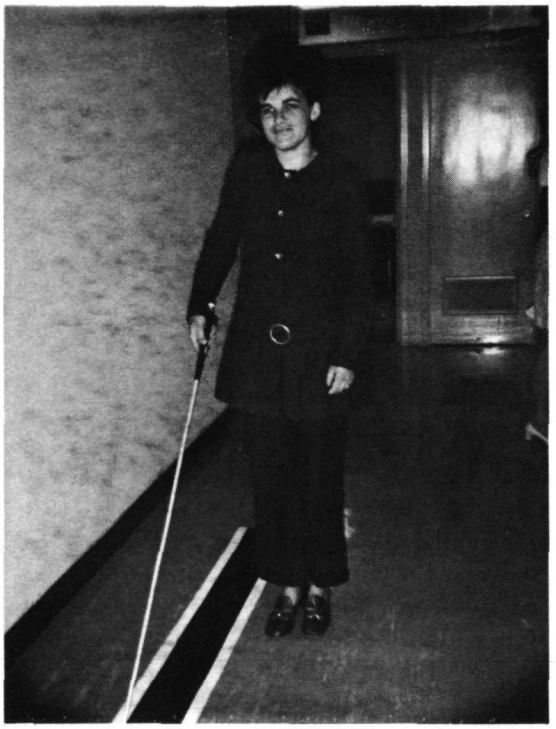


Figure 39. Coded information presented via stripes on the track.

PROBLEM CLA-3 Respiration (Apnea) Alarm for Infants

A number of newborn infants and children are subject to respiratory distress and for a variety of reasons. The distress is serious enough so that the child will die unless the onset of the distress is quickly noted and positive remedial action is immediately taken. This is particularly true if the baby is born with or develops respiratory or cardiac complications. These children rapidly develop respiratory arrest or apnea which is simply a cessation of breathing.

The problem originator was concerned with the large amount of clinician and nursing staff cribside time that was consumed in monitoring breathing of infants in this large, western children's hospital, and in fact, in all hospitals which provide care for newborn and infant children. The researcher sought to relieve doctors, nurses and attendants from the time consuming personal observation at cribside, by a technological monitor breathing device. The needed device must monitor changes in breathing on a "go" or "no go" basis and thereby alert patient care personnel in the event of significant changes.

The BATeam search retrieved NASA Technical Brief 64-10365, "automatic Patient Respiration Failure Detection System with Wireless Transmission", and the technical package related to it. This appeared to solve the problem, but was found to be excessively sensitive, sophisticated, complex and expensive for the purpose and need. Further search retrieved NASA Technical Brief 64-10171, "Subminiature Biotelemetry Unit Permits Remote Physiological Investigations" which described a high performance, biotelemetry transmitter that operates in the standard 88- to 108-megahertz FM Band, designed by Gordon J. Deboo and Thomas B. Fryer in May 1964.

The transmitter section transferred 29 January 71 underwent extensive clinical evaluation and after the desired changes were incorporated, development of the alarm system was undertaken.

Extensive modifications were made to the circuitry in Technical Brief 64-10365 to simplify the design. This was possible because of the relaxed requirements of the system. The system merely indicates respiration and does not quantitate temperature.

A technical support package is available to prospective manufacturers.

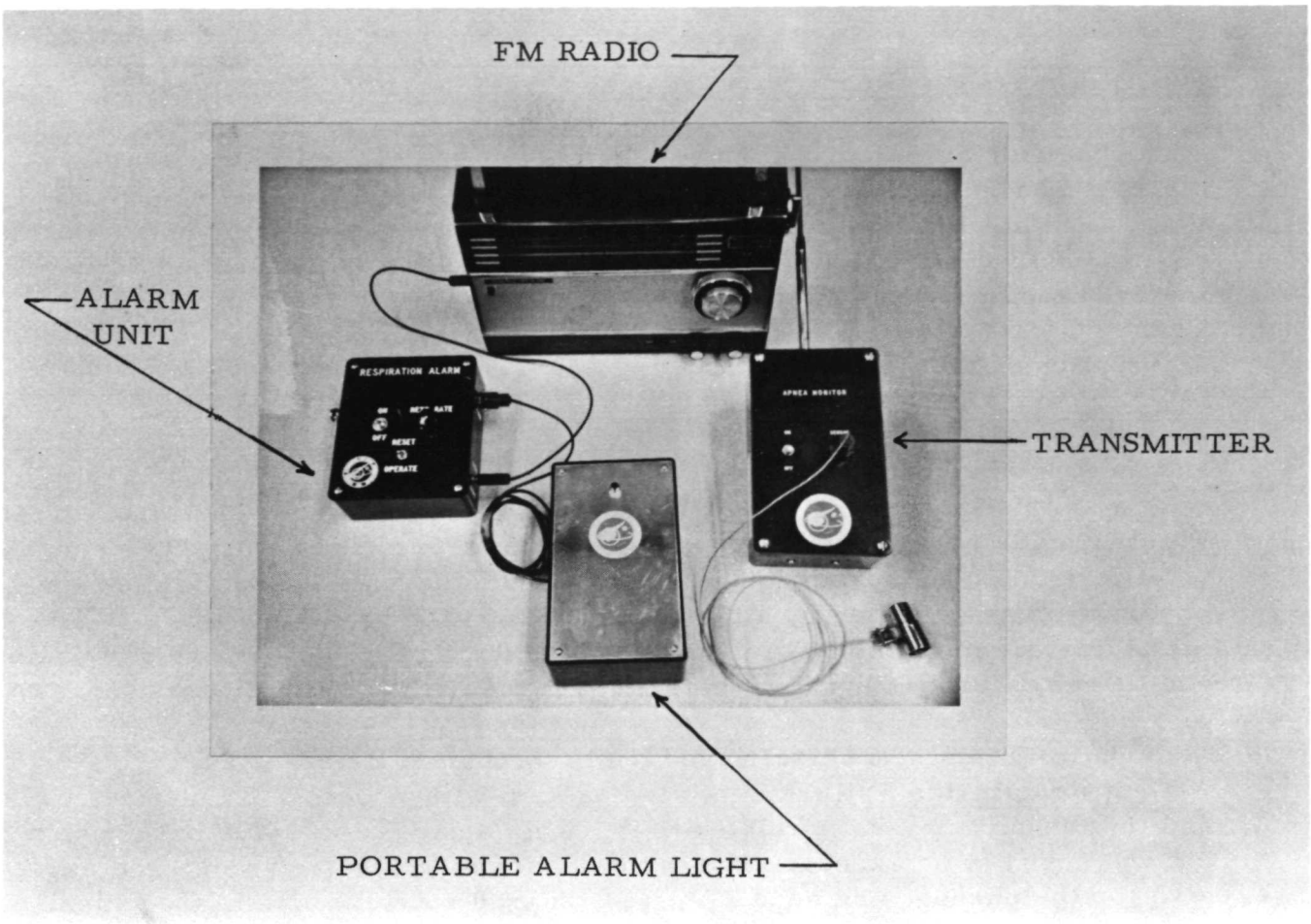


Figure 40. Apnea Monitor Alarm Unit

PROBLEM GLM-5 Intercranial Pressure Telemetry System

Injury to the brain as a result of head trauma results in swelling and increased intracranial pressure which reduces the perfusing blood flow to these delicate tissues. This can lead to inadequate oxygenation and cell death. Drugs are available to reduce intracranial pressure buildup, by causing water to be drawn out of the brain into the circulatory system. However, a quantitative guide is needed to indicate when to give the drug and to assess its effect in terms of reducing intracranial pressure.

A pressure transducer, which is mounted through a burr hold drilled through the skull, is used to monitor pressure of the cerebrospinal fluid - intracranial pressure - in these patients. The transducer assembly is connected to the electronics and recording system via wires. This connection to the skull can be a site through which infection occurs, particularly when stress is inadvertently applied to the wires during routine care of the patient. The encumbering wires must be relatively short and the associated equipment, therefore, must be close to the patient.

The problem originator requested NASA assistance in developing an improved technique, based upon wireless telemetry of intracranial pressure data. This would permit continuous telemetry of required data, twenty-four hours a day, without encumbering the patient by tying him by hard wire to the monitoring instrumentation.

The problem was accepted, a search of the aerospace data bank was conducted, and appropriate technology identified for solving the problem (miniature Telemetry System Accurately Measures Pressure Brief 66-10624. Work done at Ames Research Center. Thomas B. Fryer). The problem was approved for construction of a prototype under the AE program. Laboratory tests conducted with the prototype thus far have been encouraging.

Delivery of the prototype system in mid-July has provided encouraging preliminary data. Five pressure transducers used in hard wire monitoring were connected to the telemetry transmitter and all produced linear pressure readings in the range (0-100 mm Hg).

Preliminary testing was done with a sphygmomanometer and temperature bath to compare results with hard wire data. This evaluation continues at the present time.

Since the transducers are clinically tested and routinely used on humans, it is envisioned that the system will be in clinical evaluation soon.

Patient safety is further assured with the use of a wireless link and lower excitation voltage (+ 1Vdc) at the patient-transducer interface.

A technical support package is being compiled and will be available soon.

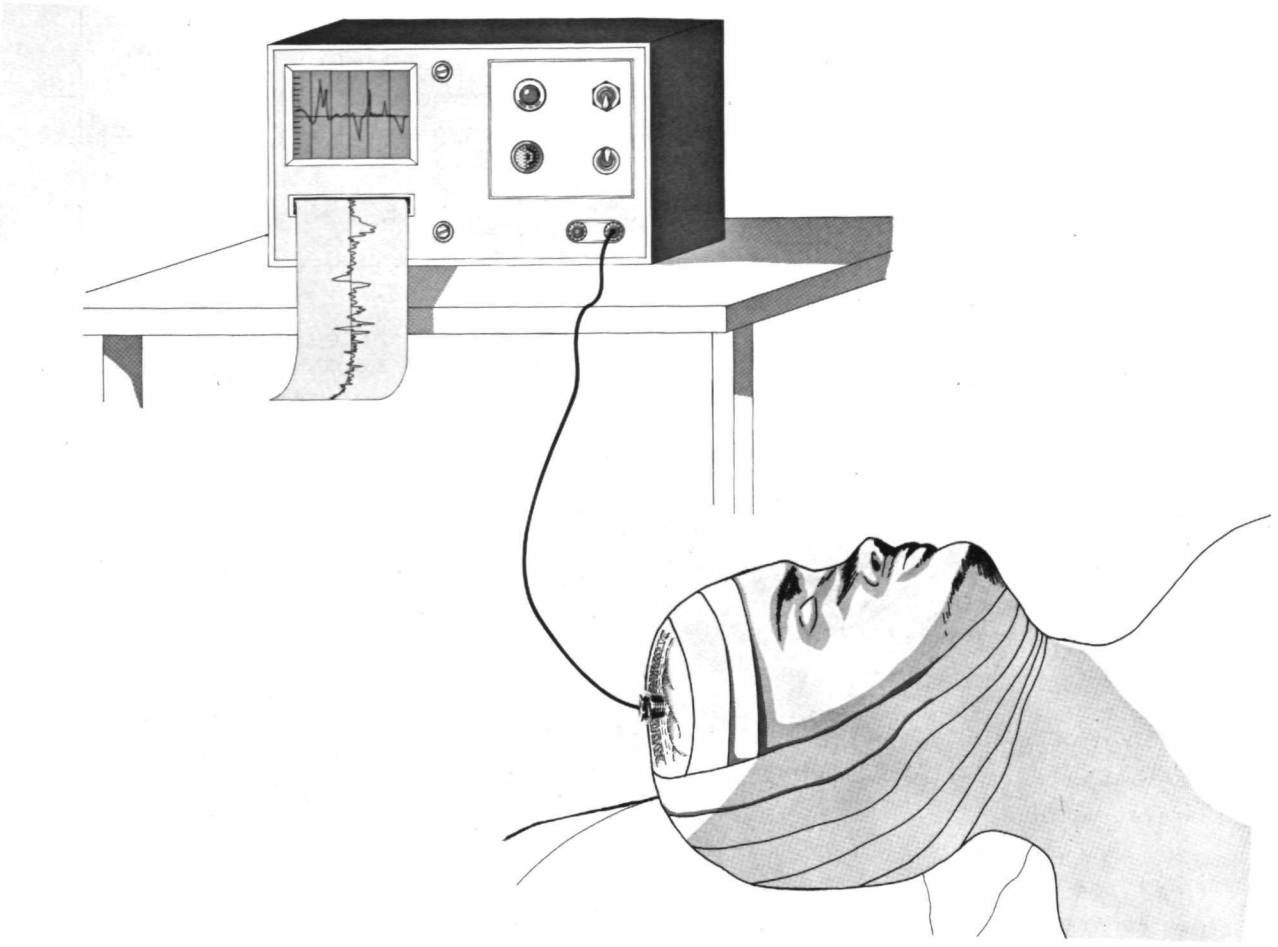


Figure 41. Method Presently in Use By the Problem Originator

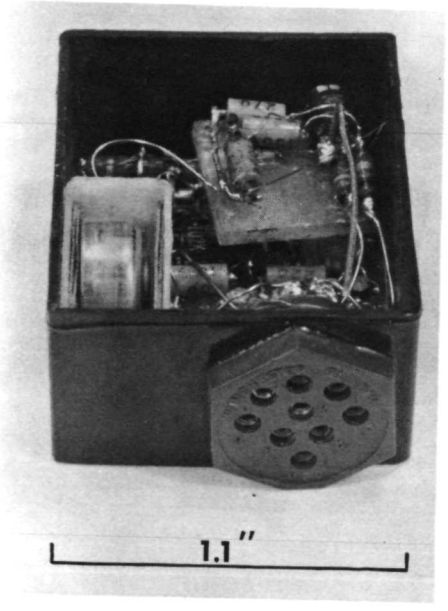


Figure 42. Prototype intracranial pressure telemetry system (if the system proves feasible in actual use, further miniaturization can be attained.)

PROBLEM WLH-2 Device to Clinically Evaluate Nasal-Airway

Clinicians in the Otolaryngology service at Wilford Hall USAF Medical Center see a large number of patients through the clinic each day, many of whom have nasal airway problems. These may be in the form of vasomotor rhinitis, nasal septal deflections, nasal polyps, etc. Treatment may consist of systemic or topical medications, desensitization when allergy is the underlying etiology, surgical correction of mechanical obstructions, and a variety of different problems which parallel or different regimens of treatment.

The clinicians needed to monitor the effects of the different kinds of treatment afforded, so that changes could be assessed as they occur in each patient, thus permitting evaluation of the effectiveness of various treatment regimens. One of the major parameters requiring evaluation centers upon acquiring adequate and reproducible data concerning airflow.

Dr. Fite requested SwRI BATeam assistance in helping provide an instrument which could be used for the above purpose. A solution to the problem was provided by modifying a nosepiece respiration monitor, described in Tech Brief 68-10438.

The monitor uses inexpensive components and measures respiration in a manner that produces a large signal with minimum delay. The system incorporates the fast response of a heated thermistor to ambient temperature changes. The thermistor, which is mounted in a special mask, is heated to an impedance of approximately 1000 ohms, is alternately cooled by the patient's breath as he inspires and warmed as he expires. High-amplitude response and zero baseline of the system are provided by a dual thermistor bridge arrangement. The bridge yields approximately 22 mc/2^{o}C (11 mv/2^{o}C per thermistor). The nulled output may be fed to a high-impedance dc amplifier, signal conditioner, oscilloscope, or recording device, depending upon the researcher's particular needs.

Figure 43. Respiration monitor in use

PROBLEM TCD-9 Portable Voice Amplification System for Individuals with partially paralyzed vocal cords

Certain diseases (such as epedemic parotitis) may be accompanied by partial paralysis of the vocal cords, with the result that the person so afflicted can only whisper. Rehabilitation of such individuals - in terms of gainful employment - would be facilitated by the availability of a small, inconspicuous portable voice amplification system which would permit verbal communication in the working environment. Personnel at the Texas Rehabilitation Commission suggested that some of the advance "hands-off" individualized communications systems developed for use by the astronauts during their space voyages might provide a solution. Accordingly, after accepting the problem, contact was initiated with researchers at Kennedy Space Flight Center (Mr. Clyde Pittman). Mr. Pittman provided a design for a personalized communications system based upon the ultra small microphone developed at the Manned Space Craft Center. Working through the TUO at MSC, arrangements were made to obtain one of the microphones from the contractor (Pacific Plantronics), so that a prototype system could be completed.

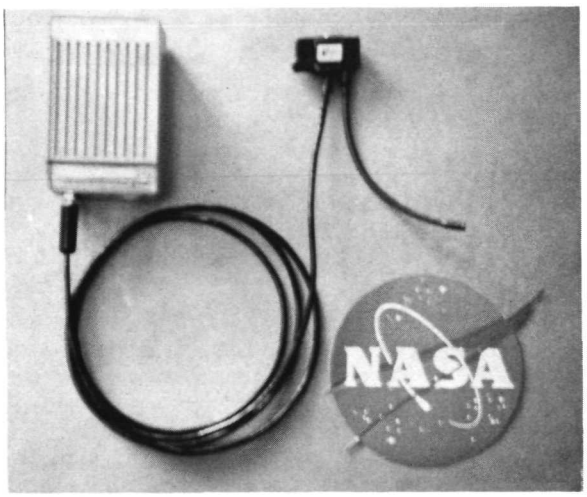


Figure 44. Close-up of the portable voice amplification system

Figure 45. The portable voice amplification system in use

PROBLEM BVA-4 Portable ECG Telemetry Receiver and Chart Recorder

The convalescence regimen prescribed for heart patients at this facility require them to be occupied in a variety of activities in several locations within the hospital complex. Many of the activities are located at considerable distance from available electrocardiograph (ECG) recording equipment. It has been necessary in the past to provide staff personnel to visit the patients in those remote locations to determine their well-being.

The problem originator sought a means for quantitatively evaluating the condition of these convalescing heart patients. He needed a portable system to monitor the ECG transmitters on each patient, and a receiver-demand-recorder in the hands of a staff member. That technology would readily provide an ideal solution to the problem he presented to NASA's SwRI Biomedical Applications Team.

A search retrieved NASA Technical Brief 64-10171, which described a biopotential telemetry transmitter. The technical support package was requested and was found to contain the desired demodulator. The SwRI BATeam proposed the addition of a small, portable strip chart recorder to the receiving package for a complete instrumentation package with all specifications requested by the problem originator.

The investigator was provided with the proposed solution and considered it ideal. He requested specifications and a cost estimate of the technology package and determined that he could support the hardware efforts required to apply the technology.

PROGRAM SNM-26 Instrument for Monitoring Pelvic Pressure of Women

The need for a portable instrument to monitor and record pelvic pressure in pregnant women was brought to the team's attention via a letter written by Dr. Marvin Chatkoff, the University of Texas Medical School at San Antonio, to the Administrator, NASA. As a result of the letter, the team contacted Dr. Chatkoff and learned of his participation in a large study involving pregnancy which is being conducted in Rhodesia. Successful conduct of the study required the availability of a device to monitor and record pelvic pressure of women in labor, to permit study of physiological data associated with this event. The aim of the study is to obtain better understanding of the mechanism of labor and birth, helping to prevent complications at birth which claim too many lives of mothers and children.

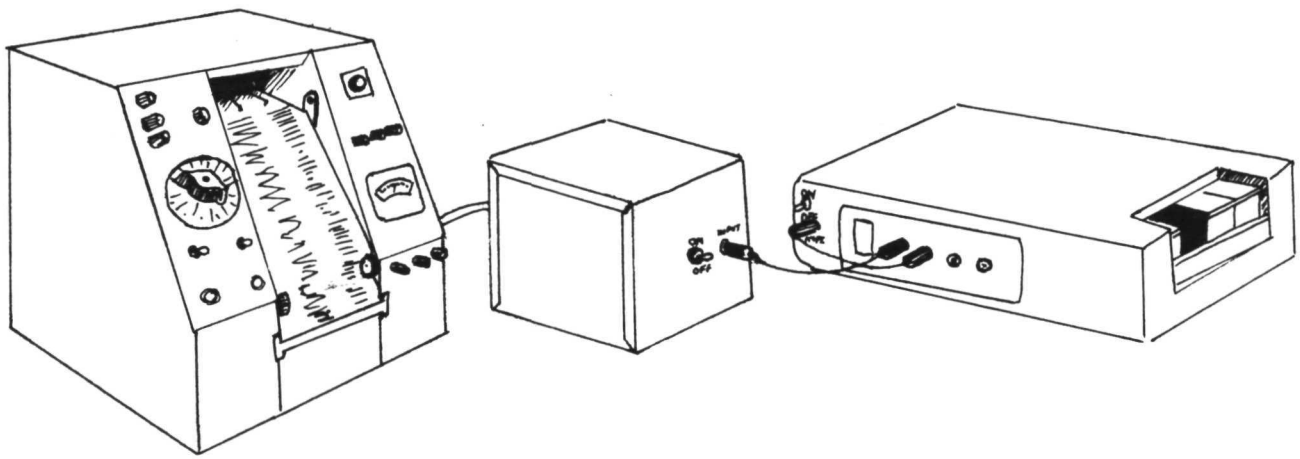


Figure 46. The Pelvic Pressure Measurement Device

The team was able to produce a prototype device capable of measuring and recording DC levels indicative of pressure using aerospace related technology. This technology is described in NASA Tech Briefs 64-10171, 67-10357 and 71-10276. All technology was modified to reflect "state-of-the are" electronics.

Brief 64-10171 describes the modulator used to place the pressure information on tape.

Brief 71-10276 describes system used to get low frequency information out of digital data.

Brief 67-10357 was modified to produce single source detection rather than 3 sources in the brief.

PROBLEM SWR-1 Custom Fitted Composite Leg Brace

The mechanics and methodology to design and fabricate a soft-tissue-conforming long leg brace were needed. The mechanics and operational requirements for a prosthetic device to support a partially paralyzed leg and thigh for a neuromuscularly weak individual, are established knowledge in the field of rehabilitation medicine. The problem of providing a reliable and strong prosthesis with reasonable weight and bulk, was unresolved. Materials were needed which were also cosmetically acceptable.

Thermosetting plastic composites of the boron-graphite epoxies appeared to have the weight/strength/reliability coefficients that were needed. These composites were originally as developed as structural materials for use in aircraft and space vehicles. The SwRI Biomedical Applications Team built a set of prototype leg braces and evaluated their applicability.

The initial fitting and testing of the long leg braces was undertaken on 18 September 1972 with the aid of the problem originator. Preliminary adjustments to the straps indicated that minor repositioning of straps should be made for comfort.

After brace adjustments were made, walking tests were undertaken. The problem originator was very pleased with the weight and configuration of the braces. Calculations on segments of each brace placed the weak point of the total brace on the long portions of the brace from the ankle to the knee. With full body weight being applied to the brace, less than 1/16 inch flexure was noted. These encouraging tests prompted further walking tests.

Further development is indicated in ascertaining integrity of the segments. Additional development will be undertaken in strengthening pressure points immediately above and below the knee.

Overall weight savings of 2:1 over her existing brace was achieved with the prototype composite brace.

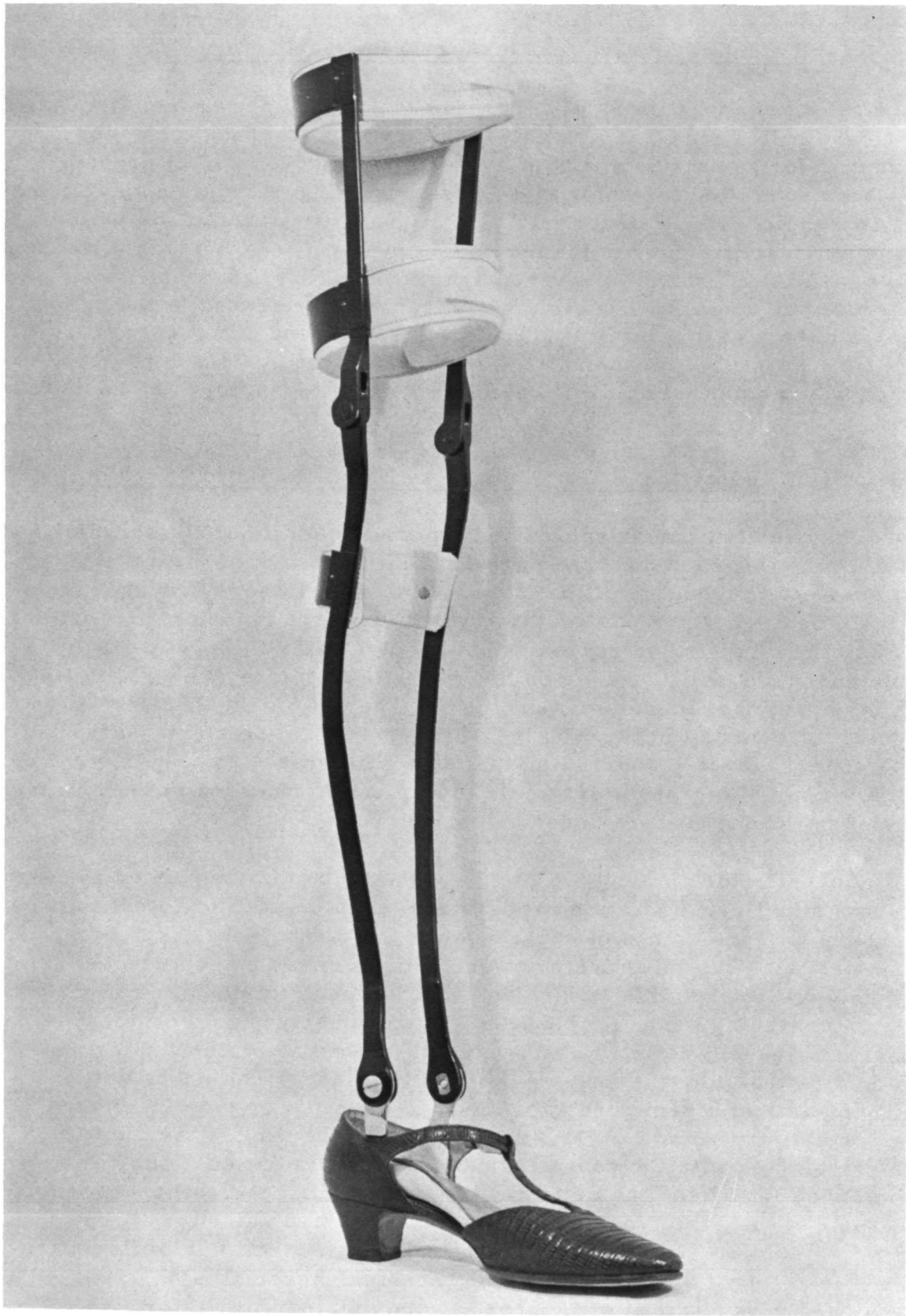


Figure 47. Custom fitted brace formed from composite materials
45.

Potential Applications of Aerospace Technology

In addition to the applications of aerospace technology previously discussed, the Biomedical Applications Team uncovered relevant aerospace technology holding potential for solving numbers of other important biomedical problems which have been submitted for solution. These are categorized as potential technology applications since final evaluation of the contribution made by the NASA technology identified by the team remains pending for a number of reasons. For example, NASA technology might require modification before it can be used; only a prototype unit might be available which cannot be released to the investigator; or the investigator's existing funding level might not permit evaluation of the suggested technology at the present time. A summary of problems for which potential applications of aerospace technology are envisioned follows:

PROBLEM SWC-12 Detection of Eye Tumors by Use of Radiation Probes

Eye tumors are very important lesions. Some are quite obviously malignant upon clinical evaluation and these are dramatic because of the quickly performed surgical enucleation of the globe. However, tumors that are not obviously malignant leave the physician with a dilemma of immense proportions. That is, if he elects the "safe" approach and he enucleates the eye in all questionable cases, he will, upon study of the removed tissue, find a definite number of hemangiomas, hematomas and nevi. The eye would therefore have been needlessly enucleated in these cases. Conversely, if he elects to treat his patients conservatively, some of his patients will suffer from the metastatic spread of the tumor. Improved diagnostic techniques are needed to prevent the occurrence of situations such as described above.

In 1970, investigators at Scott-White Clinic and Hospital requested assistance in developing a small beta radiation probe which could be used to detect tumors of the eye (Tumor tissue uptake of certain radioactive substances is greater than normal tissue). The investigators were using a small geiger counter as a probe, which was not reliable enough nor small enough for localization of the lesion. In searching the available NASA radiation detection technology, a Tech Brief (66-10252) was uncovered which described a semiconductor radiation detector that could be inserted into body tissue. The probe detecting element consists of a semiconductor diode of the junction type fabricated from a high resistivity silicon crystal doped with P-type impurities. Interaction was established with the contractor (Solid State Radiations, Inc. of Los Angeles) who performed the detector work for MSC. At first it was decided that one of the prototype detector units would be obtained and fabricated into a suitable probe configuration. However, Solid State Radiation personnel suggested that the team wait until Technical Associates, a small company who was pursuing a similar problem, completed their efforts to

develop a suitable prototype probe. This approach was adapted to conserve the BAT program's limited application Engineering funds.

Now, almost two years later, Technical Associates has perfected a prototype device based on the Solid State Radiation Technology. The device is available for evaluation by the medical community. An instrument has been made available by Technical Associates for short term evaluation by the team. Following is a description of the item:

Eye Probe and Eye Probe Preamplifier

The eye probe is a 0.25 sq. cm lithium compensated silicon detector. It is mounted in an immersion proof gas sterilizable nickel housing. The combination of this window and the detector dead layer introduce a threshold of approximately 75 keV for beta particles. The specifications are as follows:

DETECTOR:

Diffusion depth	15 microns
Drift Depth	1000 microns
Uncompensated depth	450 microns
P+ contact	Aluminum alloy
N+ contact	Lithium
Ohmic contacts	Aluminum
I_R @ 25V	$<$ 0.5 uA 22°C
N_f @ 25 V	$<$ 20 keV 22°C 1.1 usec.

CASE

Electroformed nickel	
Window	.5 mil #304 stainless steel
Potting material	Abelstick 342-1 epoxy
Contacts	Eccobond 57C conductive epoxy
Connector	Glass to metal seal; 10-32 hex nut; Silicone rubber gasket

The form of the probe has been designed for evaluation of both posterior and anterior occular lesions. The probe is connected to a low noise preamplifier by means of an hermetically sealed Microdot type connector. Normally the probe and preamplifier are assembled prior to sterilization and sterilized using ethylene oxide gas at room temperature as a unit. A single coaxial cable having an Amphenol type 75 connector on the preamplifier end and

a standard BNC connector on the opposite end for connection to the amplifier discriminator is also supplied. The sensitivity of the preamplifier is 0.5 mV/keV dissipated in the silicon detector. This combined with the input sensitivity in the amplifier/discriminator provides approximate front panel calibration of 1 keV/small division on the ten turn discriminator level dial. Normally a discrimination level between 150 and 200 keV is optimum for P^{32} betas. Preamplifier output is a positive going pulse.

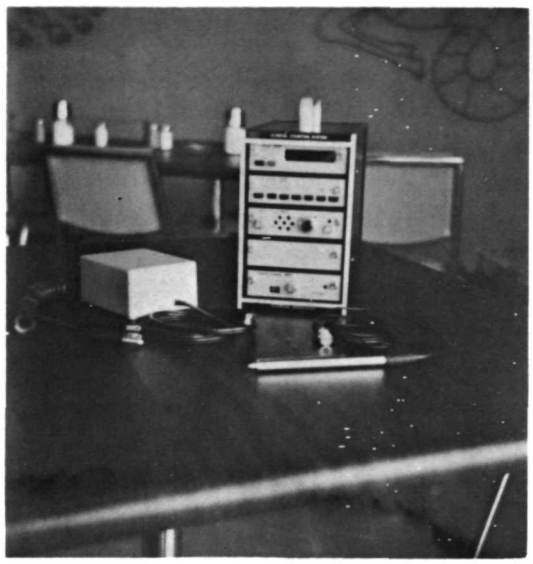


Figure 48. Eye Tumor Detector
Developed by Technical Associates
Using NASA/AEC Technology

PROBLEM RRC-8 Ultra-Thin Electromyographic Needles

Fabrication techniques and biocompatible, electrical conductor alloy, which resists breakage or warpage and which can be used as an ultra-thin, insulated electromyographic needle. The ally needs to be formed into a needle of about one and one-half inches in length and must be able to accept a very sharp point. The flexure characteristics of alloy must resist warping of the shaft during insertions through the skin. It must be biocompatible with skin, muscle and body fluids with which it must make contact. It should accept a form of positive sterilization. The usual insulation is teflon, with commercial needles having been made of stainless steel in sizes as thin as 26 gauge. However, the desired needle should be less than 0.018 inch in diameter--a size not available commercially.

Electrical potentials from muscle areas are determined by inserting electromyographic needles into tissue and establishing patterns of results. The information is needed to make diagnosis and prognosis for many patients who are being rehabilitated as a result of nerve and muscle impairments for a variety of reasons.

The required studies frequently require repeated perforations by electromyographic needles through the skin over extended time in a single session. When this time exceeds 30 minutes, the pain threshold of the patient lowers to the point of excessive pain generation. This pain has been closely associated with the gauge of thickness of the needle with the thicker needles causing excessive pain sooner.

The problem originator presently is performing between 70 and 80 of the electromyographic studies in his rehabilitation center. He has sought thinner needles from commercial sources and the best they have to offer exceeds the dimensions specified above which he feels as optimum for clinical use.

Mr. Harvey W. Herring, Langley Research Center, responded to a disseminated problem statement and indicated that fabrication of the desired ultra-thin electromyographic needles could be accomplished at the Langley facility from a variety of biocompatible alloys. Accordingly, arrangements were made through the Technology Utilization Officer, LRC, to have several prototypes fabricated. These will be evaluated in clinical use at the Rosewood Rehabilitation Center.

PROBLEM FTZ-1 <u>On-Line Breath Analyzer</u>

One of the more difficult problem areas facing the researcher who specializes in diagnosis and treatment of pulmonary disorders centers on the need for an accurate, reliable on-line analyzer for identifying the contents of expired air.

A microminiaturized quadrupole mass spectrometer system developed for the Manned Spacecraft Center by Analog Technology Corporation under Contract No. NAS9-8371 for monitoring and analyzing the breath of astronauts in space holds promise for meeting the above need. Designed to give continuous readings of the concentrations of the four major components of human breath (N_2, 0_2, CO_2, and H_20), the NASA instrument is also capable of detecting trace components. (See attached data)

An attempt is being made to obtain one of the devices for evaluation by the problem originator either from the contractor or Manned Spacecraft Center.

PROBLEM OVA-2 Measurement of Lung Compliance

Physicians need an improved technique for evaluating the overall condition of a patient's respiratory system (especially lung compliance) as a means of detecting respiratory diseases and monitoring pulmonary changes. Presently available means involve the use of pneumotachygraph screens which are attended by moisture problems and the possibility of various errors. Subtle abnormalitites and changes are not detectable by these means.

A potential solution to the problem was provided by Mr. A. Silverstein, Naval Ordnance Laboratory, Silver Spring, Maryland, in response to a disseminated problem statement. Mr. Silverstein's method provides a rapid inexpensive reading of the lung's nonlinear compliance and elasticity by using incremental readings at various static pressure levels. In the approach, the subject's nostrils are blocked while a mouthpiece brings the static lung pressure to a predetermined level, read on a manometer. A maximum-pressure relief valve is provided. A diaphragm driven by a voice coil or a piston and cylinder driven at a controlled rate, provide a small known alternating fluctuation of the combined volumes of lung and instrument. The driver frequency for the diaphragm will be low enough so that a wavelength is long compared to the lung distances. 100 Hz should be low enough, lower frequencies may be used. A corresponding alternating pressure develops which is read from an AC pressure transducer and amplified by a simple AC amplifier The incremental pressure is inversely proportional to the total incremental compliance of the system. The phase shift of the output is a measure of the elasticity or loss factor of the lung tissue. With the system, reading the pressure increment would require only a fraction of a second at each static pressure level, if a print out is used. (The phase shift corresponds to the power factor of a capacitor and the phase reading can be equally rapid if automatic.) A manual determination with a simple AC bridge would require only about 15 seconds per point.

The problem originator stated that the method holds considerable promise for rapidly measuring the compliance and elasticity of a subject's lungs as a preliminary test for Emphysema.

PROBLEM SWC-2 EEG Audiometric System for Use with Infants

Many infants and preschool children exhibit characteristic symptoms of retardation, and many of these are diagnosed as suffering brain damage while their only problem is that they are deaf or hard of hearing. Infants and small children do not respond well to standard hearing tests because of an inability to speak or accurately orally respond to testing. As a result more accurate methods are required which will enable the doctor to determine if there is indeed brain damage or a hearing defect. Properly diagnosed, treatment can be administered more concisely and deaf children can be brought to the intellectual level of their peers rather than being classified as retarded during the most important formative years of one to six.

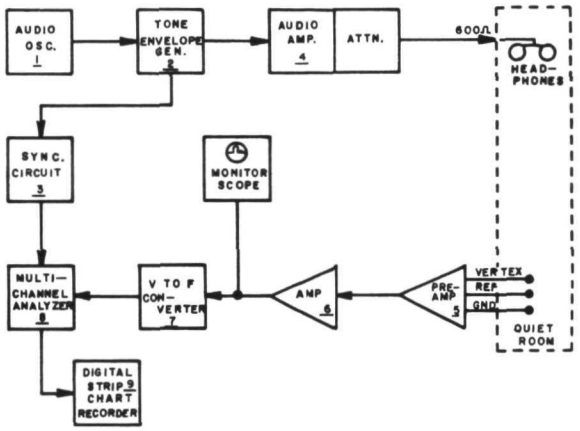


Figure 49. Instrument block diagram for the Evoked Response Audiometric System.

The problem originator and his assistants have developed an instrument which illustrates the feasibility of such an approach to check for hearing defects in infants or children, but have encountered problems that involve so much attention that reliabile data are difficult to attain. For example, using electrode and earphone attachments with infants and small children is difficult because of the child's tendency to pull them off. This problem was solved using a NASA-designed helmet with adjustable electrodes incorporated into the helmet. In addition, electrode noise and cabling problems compounded the first stage noise level of the biopotential amplifier being used. This problem was solved using a NASA-developed

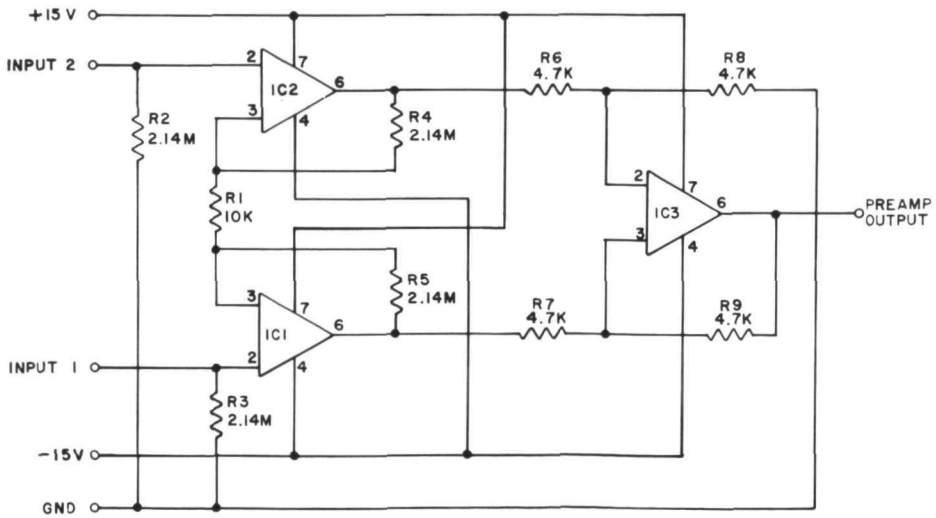


Figure 50. Preamplifier circuit diagram for Audiometric System

preamplifier. However, other problem areas remained sources of difficulty. For example, the unit is made up of cumbersome subassemblies which require much switching, knob twisting, and cabling, requiring at least two people to set up. Also, the investigator would like to vary the rise time of the tone burst, which he could not do with his existing circuitry.

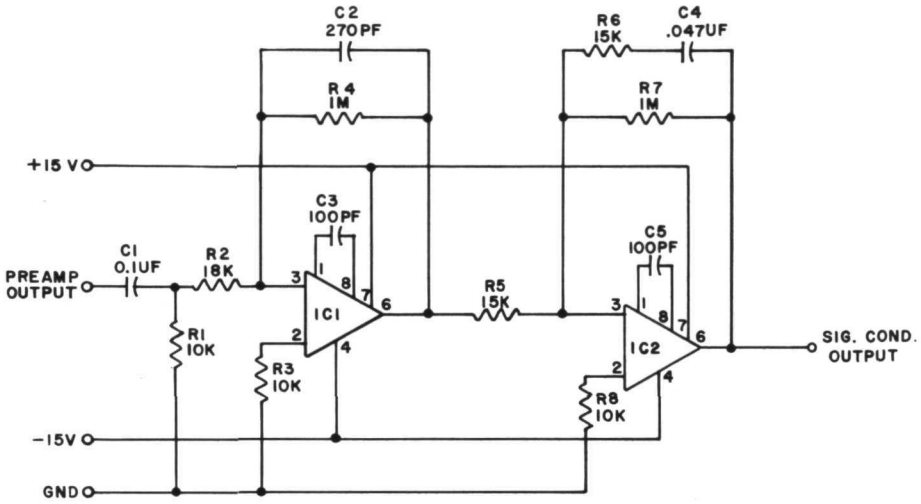


Figure 51. Signal Conditioner circuit diagram for Audiomatric System

While EEG (evoked response) audiometric systems were available, their cost--up to $20,000 --makes them beyond the financial reach of the many speech and hearing clinics where they are most needed. To provide an effective screening instrument for this use, the team proposed that the TU effort undertake appli-

cations engineering to significantly reduce the cost, size, weight and improve operational characteristics of a total system. It was felt that NASA developments in circuitry could produce a system which was both economical and portable, so as to optimize its use as a mass screening device.

Approval of the application's engineering effort was obtained with the work being accomplished at Marshall Space Flight Center. The project staff has expressed optimism that the aims outlined can be met without difficulty. It is expected that the resulting system will constitute a major contribution to rehabilitation medicine in that the way will have been paved for production of an effective, portable, and economical device which can be made standard equipment in the Nation's many speech and hearing clinics and other diagnostic facilities.

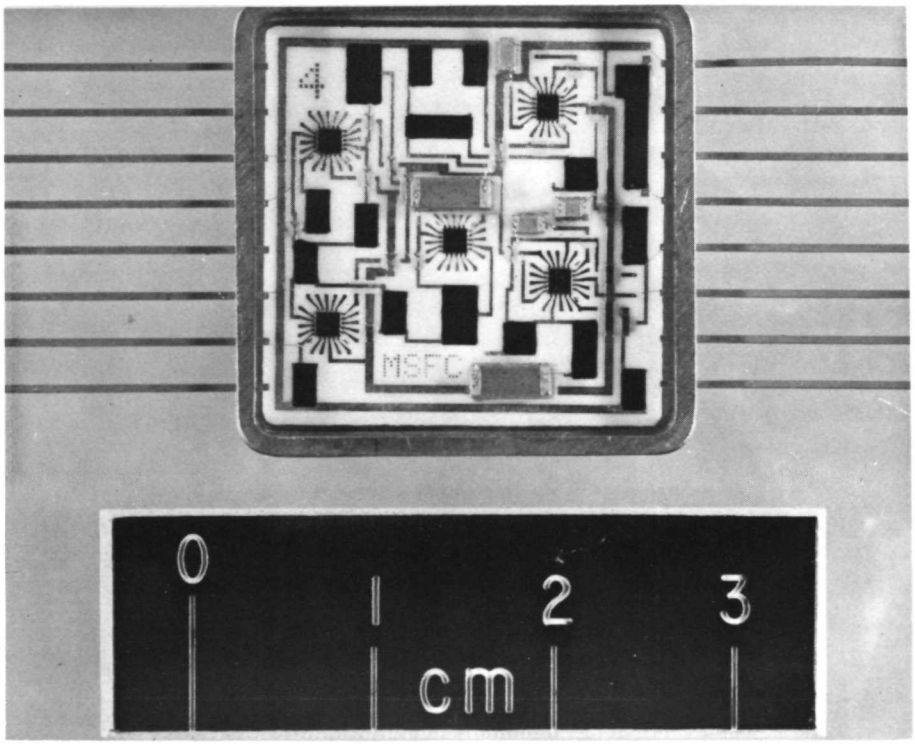


Figure 52. Blow-up of chip component showing reduction of size to fit requirements for reduced size, weight and cost of system.

PROBLEM BVA-1 X-Ray Transparent Electrodes and Leads

The problem originator and his staff attach prime importance to capabilities for monitoring physiological conditions of chronic heart attack patients where damage to the heart is involved. The investigators combine dye studies with x-rays, and simultaneously monitor with the electrocardiogram (ECG) to thoroughly measure the circulatory functions of the heart. They had encountered serious difficulties because available electrodes and their leads masked the dye study information in the arteries and veins to such an extent that the dye and x-ray study was required to be run separately from the ECG, or risk negation of the dye study effectiveness.

The problem originator requested assistance from the NASA SwRI Biomedical Applications Team. He needed special kinds of electrodes which were transparent to x-rays. X-ray transparency was essential to his research program for simultaneously acquiring ECG and dye study data on his heart attack patients.

NASA Technical Brief 68-10363 described an x-ray transparent material and was retrieved as a result of a search by the team. The Marshall Space Flight Center was contacted and suggested that an ideal solution to this problem was a slight modification of the material by producing a 1-mil, aluminized mylar used in liquid crystal technology.

The proposed technology was presented to the problem originator, who requested a working sample and indicated he would evaluate it at the earliest possible date. Presently the SwRI BATeam is evaluating this technology to determine optimum thickness of aluminized mylar for use as an electrode and lead materials in order to solve this problem.

PROBLEM OVA-4 Method for Assessing Sleep Physhophysiology in Extreme Environments

Extreme, exotic, and stressful environmental conditions are encountered at Amundsen-Scott Station, Antarctica. The investigator is assessing generated, long-term psychophysiological responses to use in constructing an overall picture of the general processes of adaptation to these extreme conditions. He collects and analyzes the psychophysiological concomitants of sleep (as a definitive state of consciousness).

A technique to analyze sleep was needed which would avoid the need for human experts to interpret voluminous conventional EEG data gained over extended periods of time and be reliable under extreme environmental conditions. It was found that a NASA-developed electronic sleep analyzer fit the basic requirements of the problem originator. The instrument, described in Tech Brief 70-10110, automatically monitors the stages of sleep of a human subject. It was designed for possible use in manned spaceflight monitoring and would therefore have to be independent of human experts for the proper interpretation of data over extended periods.

This analyzer differs from previous sleep analyzers in that it includes the following features:

- Packageable in small size (for use on a spacecraft)
- Requires little telemetry bandwidth or time
- Designed specifically for the determination of state of sleep
- Operational in real time
- Requires only channel of EEG activity (central or occipital)
- Not excessively biased by occasional electrode or movement artifacts.

The investigator will use the analyzer at the Amundsen-Scott Station, Antarctica to expedite the collection and analysis of the psychophysiological concomitants of sleep, which provides information needed to construct an overall picture of the general processes of adaption and maladaption to extreme environmental conditions. It is anticipated that a modified version of the sleep analyzer will be developed for the investigator by the manufacturer who developed the flight-qualified model for space application.

Figure 53. The NASA-Developed Automatic Sleep Analyzer will be used to aid in collecting and analyzing psychophysiological concomitants of sleep.

PROBLEM RNV-37 Surgically Implanted Peroneal Stimulator

A large number of persons suffer partial or complete paralysis as a result of accidents or illnesses, with concomitant muscular atrophy and nerve deterioration. Researchers at Rancho Los Amigos Hospital wanted to investigate the extent to which long term electrical stimulation can promote restoration of peripheral nerves, with a view of rehabilitating these individuals.

A complete surgically-implantable pulse circuit with batteries, electrodes, and a magnetic switch for external control was needed for this purpose.

The SwRI BATeam located relevant technology to solve the problem. A subminiature, high performance implantable biopotential telemetry system developed at NASA Ames Research Center was identified via a manual search of aerospace literature (NASA-TM-X-54068). Features of the transmitter include small size, conventional, easily available, inexpensive components, and an assembly technique which permits easy construction.

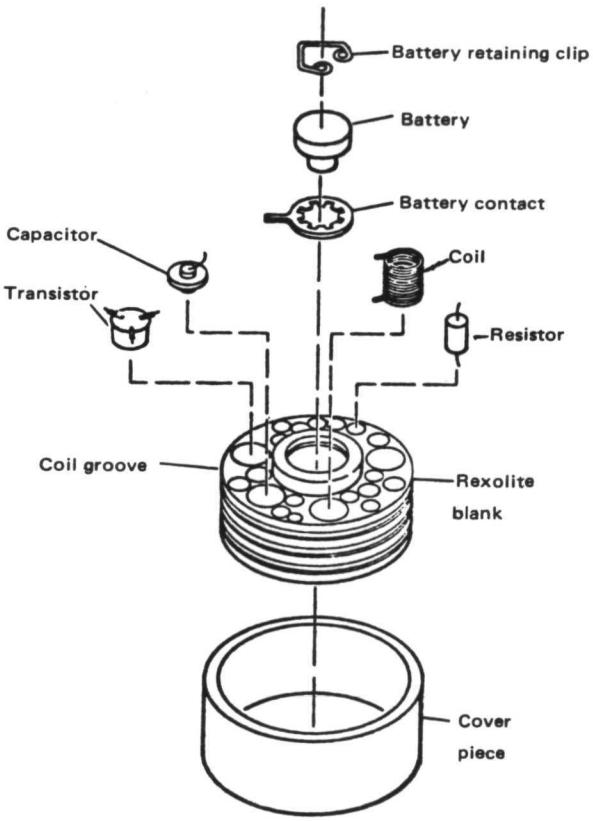


Figure 54. Component assembly of NASA/Ames Implantable Biopotential Transmitter.

In addition, electrode technology was identified which will be adapted to provide ultra-flexible, stretchable, implantable electrodes of the type perfected by Mr. S. A. Rositano at Ames Research Center for nerve stimulation or sensing within the body. In a description of the newly developed special purpose electrode (TSP 70-10420), a tiny conductive cuff is placed around the nerve providing a soft, non-abrasive contact and 360 degrees of conductive surface. The electrodes and wires are made of impregnated elastomeric material which is stretchable up to 40 percent of its length while maintaining excellent conductivity. This is a significant improvement over normal metallic lead wires which always present the danger of breaking at the junction of the electrode. Approval has been granted to pursue development of the stimulator under the application engineering program.

PROBLEM OCH-1 Lightweight Long Leg Braces for Children

Long leg braces traditionally have been fabricated with steel supports. Steel has been the preferred support material because of its required dependability and strength.

Critical problems have developed when the steel-reinforced, long leg braces have been applied to children. Children have been unable to cope with the bulkiness and weight of the prosthesis. Most children have resisted therapy and have delayed their treatment regimes because they would rather drag themselves around and crawl than to struggle with the braces.

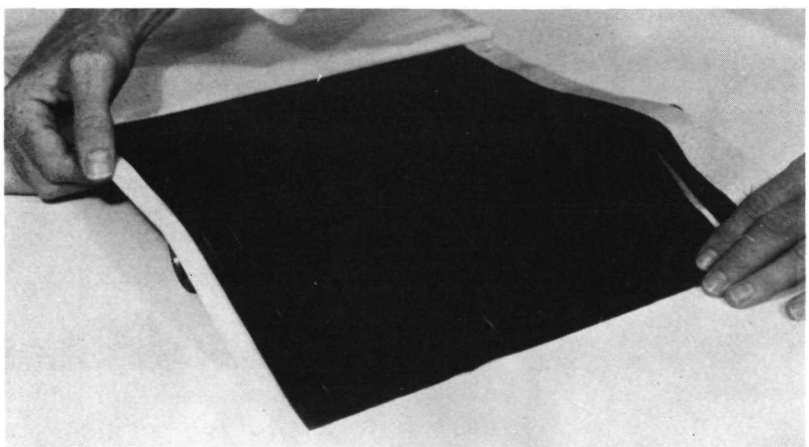


Figure 55. View of composite material before curing.

The problem originator sought BATeam assistance in locating a suitable aerospace plastic with approximately the same strength and dependability of steel without the undesirable weight and bulk. NASA Technical Brief 71-10217 "Promising Boron/Graphite/Resin Composites," was retrieved as a possible solution. Contact was then made with the aerospace contractor that developed the original products and he explained the nature of the process. The pre-cured materials are similar to cloth fabric in nature and are easily molded to desired forms and shapes for curing. Some adjustments can be made so that proper cure takes place at about room temperatures. The finished material is hard, resilient, has exceedingly high strength, and is very dependable. The combination of pre-cure and postcure characteristics of the resins suggests the complete solution to this problem.

Figure 56. Prototype long leg brace with composite inserts to reduce overall weight.

PROBLEM SJH-1 Interfacing Biochemical Autoanalyzers with a Computer
PROBLEM SJH-2 Interface Schematics for Incorporation of Biochemical Analyzers

A problem originator at a southwestern hospital wished to interface several biochemical autoanalyzers used in the Pathology Department with computers to increase the efficiency of specimen analysis. This, in turn, would help introduce savings in cost for laboratory service which ultimately could be passed along to the patient receiving such services. After discussing the problem, the team investigated the computerized diagnostic facilities at the NASA manned Spacecraft Center, Houston, and concluded that much of the technology and computer programs required were available. Accordingly, arrangements were made for the problem originator to attend a seminar at MSC presented by Dr. E. C. Moseley concerning the Center's Medical Information Computer Systems. Arrangements were also made for the problem originator to meet with Dr Craig Fischer, head of the MSC Medical Directorate's clinical laboratory. As the result of these meetings, the problem originator

expressed confidence that if he could obtain copies of the computer programs and related data, he would be able to adapt them for use at his hospital.

Working through the MSC Technology Utilization Officer, the team arranged to obtain (1) a listing and magnetic tape containing all MEDATA-related programs now in operation at MSC, (2) Technical documentation of these programs, and (3) a document describing the overall system. These have been transmitted to the problem originator for use in perfecting his system. It should be noted that the MSC materials must be adapted for use in the hospital's less sophisticated computer system. Therefore, application of this technology will be delayed for some time. However, the problem originator's enthusiasm and resolve may help shorten the time which would ordinarily be required to adapt the complex MSC program materials.

PROBLEM RNV-34 Pressure Sensitive Device for Use in Tongue-Operated Control Systems

Ever increasing numbers of people are surviving encounters with accidents or disease which leave them with severe neuromuscular limitations or amputations. In general such patients are dependent upon society for their care. The extent of their dependence relates in part to the extent of the disability. It also relates to the availability of prosthetic devices and methodology which can be used to enhance their potential for increased self-sufficiency.

Total care for amputee and paralytically disabled patients can be extremely expensive. For example, if a disabled person can merely take a wash cloth and wash or wipe his face, it has been estimated this in itself can result in a saving of about 50% of patient care cost.

Investigators at a member research team at Rancho Los Amigos Hospital have developed a high degree of specialization and competence for innovating a variety of orthopedic methodology and devices. One of the group's prime interests centers upon optimizing the individual patient's motility. In this connection, they have developed a basic self-propelled wheelchair and have improved it by several modifications and addition of electric motors. The improved wheelchair can be operated forward or backward, turn, and even go up and down inclines or stairs by assist devices. The group requested assistance from the NASA Biomedical Applications Team is developing improved control devices for the wheelchair. The group is particularly interested in a control system which can be used by paralyzed or amputee patients who can use only the muscles of the eyes, mouth and head area for control purposes. Particularly desired were tongue-operated switch controls which could be used to provide sequential off-on control of the wheelchair or other assist device.

The team was able to identify a NASA innovation (an insulated gate, field-effect transistor) capable of performing strain-sensing and amplification functions in one integral device, which appeared to meet the investigators precise needs. The researchers felt that the NASA innovation can be incorporated into a reliable, saliva resistant switch that is small enough to fit the lingual area of the mandible and sensitive to tongue pressure operation. This would permit totally paralyzed patients to control such devices as wheelchairs by tongue movements.

Arrangements were made with Langley Research Center to produce additional prototypes of the devices. Five discrete CdS PI-FET strain sensors have been delivered to the Rancho Los Amigos Hospital for intensive evaluation. A test is being set up to determine the performance of the devices under simulated conditions. The researchers are optimistic that the sensors will prove satisfactory for application to the control function described above.

POTENTIAL TECHNOLOGY APPLICATIONS DROPPED DURING THE PERIOD COVERED BY THIS REPORT

Problem Number	Reason for Dropping
HSR-6	Investigator developed his own switching device.
UTM-24	Lack of investigator's desire to pursue relevant NASA technology
HSR-1) HSR-2) HSR-3)	Investigator decided on a new approach to the problem by custom fabricating items to fit each individual patient. NASA technology which had been identified was no longer relevant to the solution of the problem.
RNV-28	Proposed solution too costly for adoption.
UTM-9	Lack of investigator's desire to pursue relevant NASA technology.
BLM-11) BLM-11A)	Lack of investigator's desire to pursue relevant NASA technology.

III. SUMMARY OF PROBLEM ACTIVITY UNDERTAKEN DURING THE REPORT PERIOD

PROJECT ACTIVITY SUMMARY

The following is a summary of project activity by the team for the period September 1971 to September 1972. Additional information concerning project activity is attached as Appendix A.

New Problems Accepted	58
Problems Rejected	0
Problems Inactivated	75
Problems Reactivated	4
Total Problems Currently Active	167
Preliminary Problem Statements Prepared	58
Problem Statements Submitted for Review	2
Problem Statements Disseminated	1
Responses to Problem Statements	11
RDC Computer Searches Initiated	27
Other Searches Initiated	0
Search Evaluations	42
Potential Technology Applications Claimed	15
Technology Applications Claimed	19

HEALTH AREA IMPACT

The health area impact categories for new problems accepted during the report period are shown in Table 1.

DESCRIPTION OF CURRENTLY ACTIVE PROBLEMS

A description of currently active problems categorized by health areas is attached as Appendix B.

TABLE 1. IMPACT AREAS OF NEW PROBLEMS ACCEPTED DURING THE PERIOD COVERED BY THIS REPORT

Health Area Impact Categories	Analytic Inst. Systems	System Components (Equip.)	Computer Programs	Prosthetic Devices	Materials/ Chemicals	Therapeutic Equipment	Other	Total
Communicable Disease								
Multiphasic Health Screening								
Rehabilitation Medicine	3	18		6	4	4		35
Artificial Organs								
Organ Assist Devices		1		1				2
Mental Health								
Heart Disease Treatment	2	1						3
Cancer Detection						1		1
Ecology								
Health Care Cost Reduction		1	1					2
Remote Health Services								
Medical Personnel								
Kidney Disease				1				1
Infant Mortality		1						1
Respiratory Disease		1					1	2
Surgical Procedures								
Dental Medicine	2	5						7
Basic Medical Research	2				1			3
Other								
Total	9	28	1	8	5	5	1	58

SYMPOSIUM AND CONFERENCE ATTENDANCE

Charles J. Laenger, Sr.	Annual Convention, National Rehabilitation Association, Arkansas Chapter, June 14-16, 1972, Hot Springs, Arkansas. Presentation was given on the NASA Biomedical Applications Program.
Linda L. Eckhardt	Texas Commission for the Blind, Annual Meeting of the Alummi Association, June 3, 1972. Presentation was given on the NASA Biomedical Applications Program.
Dennis C. Jamvold Linda L. Eckhardt Charles J. Laenger, Sr.	Texas Medical Association Convention, May 12-13, 1972, San Antonio, Texas. NASA display depicting Biomedical Applications Program activity was presented.
David F. Culclasure, Ph.D.	Social and Rehabilitation Service, Region VI, Conference, March 24, 1972, Austin, Texas. NASA display depicting Biomedical Applications Program activity was presented.
David F. Culclasure, Ph.D.	Seminar on the Biomedical Applications Program, U.S. Army Medical Research and Development Command, OTSG, April 12, 1972
David F. Culclasure, Ph.D.	Seminar on the Biomedical Applications Program, U.S. Navy, Surgeon General's Staff, April 13, 1972
David F. Culclasure, Ph.D.	Regional Conference on Services for the Visually Impaired, April 10-12, 1972, Little Rock, Arkansas. Presentation on Biomedical Applications Program was given.

Dennis C. Jamvold David F. Culclasure, Ph.D. Charles J. Laenger, Sr.	National Engineers Week, February 20-26, 1972. NASA display was presented depicting Biomedical Applications Team activities.
C. J. Laenger, Sr.	"Technology Transfer to Radiology" Conference, February 18-21, 1972, Albuquerque, New Mexico. NASA Biomedical Applications Team presentation was given.
David F. Culclasure, Ph.D. Earl K. Calvert C. J. Laenger, Sr. R. L. Wilbur Linda L. Eckhardt	"Symposium on Composite Materials" February 4, 1972, San Antonio, Texas. NASA developed composites applicability & rehabilitation was discussed.
C. J. Laenger, Sr.	Fourth Annual Conference on Electronics in Medicine, March, 1972, Chicago, Illinois. Biomedical Applications Team presentation was made.
C. J. Laenger, Sr.	IEEE Convention, March, 1972, New York, New York. NASA display and patient assist device were presented.
R. L. Wilbur C. J. Laenger, Sr. David F. Culclasure, Ph.D. Linda L. Eckhardt	Biomedical Applications Team Seminar, January 21, 1972, San Antonio, Texas. Demonstration of NASA Technology as applied to the field of rehabilitation.
David F. Culclasure, Ph.D.	Symposium with the Vetrans Administration Central Office, February__, 1972. NASA Contributions to rehabilitation were discussed.
Charles J. Laenger, Sr. Dennis C. Jamvold	National Rehabilitation Association Conference, Oct. 10-13, 1971, Chicago, Illinois. NASA display was presented.

David F. Culclasure, Ph.D. Dennis C. Jamvold	MEDATA Seminar, October 6, 1971, San Antonio, Texas. NASA contributions to computerized medical technology were discussed.
Dennis C. Jamold Earl K. Calvert	Texas Manufacturing Association Convention, October 27-29, 1971, Houston, Texas. The BATeam display was presented.

NEWS RELEASES
NASA BIOMEDICAL APPLICATIONS TEAM
SOUTHWEST RESEARCH INSTITUTE

SAN ANTONIO NEWS Tuesday, December 14, 1971

New system lets patients do things for themselves

By DAVID DREIER

With just a slight tip of the head, a flick of the eye or a puff of breath, a totally immobilized patient will now be able to perform such functions for himself as raising his bed or switching on the television — easy for most people, but previously impossible for him.

"This is the first time that quadriplegics and multiple amputees will be able to do things for themselves on this scale," said Dr. David F. Culclasure, leader of a Biomedical Applications Team at Southwest Research Institute, in explaining a new electrical control system developed under a special program of the National Aeronautics and Space Administration.

The program funds three biomedical research teams in the United States to develop new applications for advanced technology derived from the space effort.

IN ADDITION, four other research centers are working on non-medical applications and six regional centers deal with industrial applications of technology. Fifty-nine medical institutions also are participating.

The new system developed at SwRI is fitted to a special hospital bed and allows an immobilized patient a considerable degree of control over his immediate environment.

The system can be controlled by the patient through one of several switches than can be connected. For patients with slight movement in their extremists, foot or finger switches are employed. If a person can move only his head, he is fitted with a special headset. Eyeglasses sensitive to movements of the iris are used by patients who are totally incapable of bodily movement.

THE SWITCH is wired to a logic unit with several channels, each one leading to a different device — a light, the television, the bed raising and lowering mechanism, a special device for turning magazine pages, or whatever else is added to the system.

Each switch is actually a pair of switches. The patient activates the left-hand switch to get to the proper channel on the logic console, and then the one on the right to carry out the function.

The new system could be of enormous medical benefit, since it is estimated that there are some 100,000 quadriplegics in the United States, not to mention the thousands of other people who have been partially immobilized.

Culclasure said, "The morale of such pateints is markedly improved and the demands on patient care personnel are greatly relieved by any device or procedure which generates self-sufficiency capabilities."

RESEARCH TO benefit quadriplegics will not stop with this latest development, Culclasurre said.

He explained that work in conjunction with Hot Springs Rehabilitation Center in Little Rock, Ark. is now in progress which hopefully will lead to a device enabling paralyzed persons to use their hands. Such a device, he added, is now in the experimental stage.

"Presently, the hand movements it allows are not too refined," he said, "but we're working on it." The device employs the same type of eyelglasses sometimes used with the bed, which are connected electrically to a metal mechanism controlling hand movements.

IT WAS THE Hot Springs Center also that came up with the idea for the hospital bed system, culminating in the Southwest Research Institute project.

The special bed will now be taken to NASA headquarters in Washington, D.C., for further demonstrations, according to Clare Farley, deputy administrator of NASA's Technology Utilization department. He and two other NASA officials were in San Antonio Monday to attend a press conference at the institute.

Farley said that the bed will be shipped in a week to the Marshall Space Flight Center in Huntsville, Ala., where it will be used in a specially equipped room in Huntsville Hospital.

New Medical Device

Linda Eckhardt of Southwest Research Institute demonstrates a special mechanism for turning pages of a magazine by just moving her head.—Staff Photo.

SwRI Designs Bed Logic Unit For Paralytics

By DAVID DRIER
Of the Express Staff

An electrical control system fitted to a hospital bed developed by Southwest Research Institute will permit otherwise helpless paralytics and multiple amputees to perform a number of simple operations for themselves.

The system, activated by one of several switching devices using head or eye movements or puffs of breath, was developed by a SwRI biomedical applications team working under a program of the National Aeronautics and Space Administration. The NASA project seeks ways of applying new technology derived from the space effort.

The hospital bed system consists basically of the patient-controlled switch and an electronic logic unit which directs patient input to the proper function, such as raising or lowering the bed, turning on the television or flicking on the light.

In the bed demonstrated Monday at the institute, the patient lies with his head in a special headset with a switch on either side. He turns his head to the left several times until the proper channel shows no the logic console. Then, one head turn to the right activates the mechanism for whichever function is wanted performed.

The research was initiated at the request of the Hot Springs (Ark.) Rehabilitation Center, one of 59 medical institutions participating in the biomedical applications team program. The center asked the institute group about the possibility of developing control methods other than the already-existing eye switch, which some patients find uncomfortable.

The team at SwRI is one of three in the country doing medically related work for NASA. The director of the team is Dr. David F. Culclasure.

December 14, 1971 THE SAN ANTONIO LIGHT

NASA Idea Develops Help for the Bedridden

By ED CASTILLO

A control system designed to enable bed-confined quadriplegics and multiple amputee patients to become more self-reliant, soon may become standard equipment at all military and veteran hospitals.

Fitted to a hospital bed, the system, developed on the basis of an idea from the National Aeronautics and Space Administration, permits a patient to use a puff of breath, or slight physical movement to control the position of the bed and to operate a variety of electrically powered applionces.

VISUAL PROOF

The system was demonstrated at Southwest Research Institute Monday before several SRI and NASA officials, when Miss Linda Eckhardt, acting as a patient, gave visual proof of the effectiveness of the control system.

Miss Eckhardt demonstrated her ability to operate a television set, turn magazine pages on a stand at her side and operate radio and light switches, all by slight movement of her head to one side or another and by putting slight pressure on an activating system.

MISS LINDA ECKHARDT, acting as a patient, demonstrates, by slight movement of her head, how to flip the pages of a magazine. (Staff Photo.)

Development of the system was reported by a SWI biomedical applications team, working in a NASA program designed to transfer aerospace technology to new and practical uses on earth.

Dr. David F. Culclasure, leader of the institute team, pointed out patients who are paralyzed in all four limbs (quadriplegics) and multiple amputee patients, almost were totally dependent upon support from patient care personnel for any activities or interests in which they can participate.

Declared Culclasure, "The morale of such patients is markedly improved and the demands on patient care personnel are greatly relieved by any device or procedure which generates self-sufficiency capabilities."

The control system can be adapted to individual capabilities, the official said. Appliance control selection, and on-and-off switching can be accomplished either by breath expended against small paddles suspended before a patient's face, by slight turning of the head, by toe or finger switch or by eye-movement switch, he added.

Clare Farley, deputy administrator, technology utilization, NASA headquarters, Washington, said much has been done to improve such control systems during the past five years.

LATEST DEVICES

Farley said plans now call for the installation of the latest biomedical devices at Huntsville Hospital in Alabama as a pilot project. Installment at other hospitals will follow he added.

The NASA official said SRI, Stanford Medical School and Research Triangle Institute in North Carolina have been working in the development and improvement of the control system.

"There presently are about 100,000 quadriplegics in the country," Farley said. He predicted control systems such as the one demonstrated, soon will be in use in military and veteran's hospitals across the country.

TEXAS REHABILITATION COMMISSION
PUBLICATIONS REFERENCING BIOMEDICAL APPLICATIONS TEAM ACTIVITY

RESEARCH UTILIZATION

Vol. 2, No. 3 ...ABILITATION COMMISSION Summer, 1972

TEXAS MEDICAL ...

The Texas Medical Associati... conference was held in San A... Texas, on May 12, 1972.

A panel entitled "NASA Bioengineeri... and Biomechanical Developments--Rehabilitation Implications" was presented by:

Mr. Jess M. Irwin, Jr., Commissioner
Texas Rehabilitation Commission
Mr. Jack Dale, Texas Manufacturers Association
Mr. Jim Richards, NASA Technological Utilization Office, Washington, D.C..

The panel was emceed by Dr. Arthur E. Grant, Program Chairman for the Physical Medicine and Rehabilitation Division of the Texas Medical Association.

The purpose of the panel was to explore with the members of the Texas Medical Association the gap existing between research findings and prototype assist device models and the mass utilization by handicapped individuals.

Proto-type devices developed by NASA were on display. They included a Sound Monitor for use by the deaf as a voice gauge; a light-detection meter for the ...lind; low-cost foam cushions for re...ial treatment and prevention of de...us ulcers; and several assist de...or the quadriplegic and para...tient.

Un... ...ce
vehic...

Dr. Marvin C. ... ...dministrative Medical Consulta... ...reported that subsequent sm... ...meetings the following day br... ...sts from Physiatrists and ... ...s for additional informati... groups have been added to t... ...h Utilization Report (RUR) mai...

For more information, please writ...

Arthur E. Grant, M.D., Chairman
Department of Physical Medicine
University of Texas Medical School
7703 Floyd Curl Drive
San Antonio, Texas 78712

OPEN SESSION

INDEX

GRANT APPROVED

The Texas Rehabilitation Commission Central Office was notified by SRS that the Research Utilization grant proposal, entitled "Acceleration and Expansion of Diagnostic Services in a Houston Vocational Rehabilitation Project" had been approved.

The project will begin immediately as part of TRC General Programs, under Doyle Wheeler, Assistant Deputy Commissioner.

The separation of diagnosis from the remainder of the rehabilitation process affords an opportunity to study the results of several innovative diagnostic procedures funded under previous SRS R&D projects and brought together for utilization in this project.

RESEARCH UTILIZATION REPORT

Anne T. Kohler -- EDITOR
Research Utilization Specialist
Texas Rehabilitation Commission
1301 West 38th Street
Austin, Texas 78705 512/452-8192

NEW MEMBER

John A. Gronouski, Ph.D., Dean, Lyndon B. Johnson School of Public Affairs, University of Texas, is a new member of the Research Utilization Advisory Committee.

Dean Gronouski is a graduate of the University of Wisconsin, was Ambassador to Poland in 1965-68, and was Postmaster General of the U.S. in the Cabinets of Presidents Kennedy and Johnson, 1963-65.

Dean Gronouski brings with him the vast resources of the LBJ School of Public Affairs and the interest of the school in the utilization of research and community affairs.

HANDBOOK AVAILABLE

The *Counselor Handbook - Occupational Information for Lubbock, Texas* was recently distributed to TRC counseling and supervisory staff in Region I.

The *Counselor Handbook* is the result of a cooperative effort between the Texas Tech University Counselor Training Program and the Research Utilization Section of TRC Staff Development.

The handbook is a comprehensive listing of Lubbock companies, job types and job levels, designed to aid counselors in client placement.

---*Disability Occupation Study*
continued from page 8

NUMBER OF DIFFERENT OCCUPATIONS IN WHICH 10 OR MORE CLIENTS CLOSED

Disability	*No. of Occupations*
Benign Neoplasm	2
Cardiac, circ.	2
Dis. nervous syst.	3
T.B.	3
Cond. teeth	6
Other digest. syst. cond.	6
Hernia	8
Cond. genito-urinary	9
Psychoneurotic dis.	10
Limb imp.	16
Psychotic dis.	25
Alcoholism	35
Mental Retardation	49
Personality dis.	54

Carol J. Whitcraft, Ph.D.

Research and Follow-up Services
Texas Rehabilitation Commission
1301 West 38th Street
Austin, Texas 78705

---*RIS National Field Trial Locations*
continued from page 3

Dr. Frank Lawlis, Director
Counselor Training Program
Department of Psychology
Texas Tech University
P.O. Box 4100
Lubbock, Texas 79409

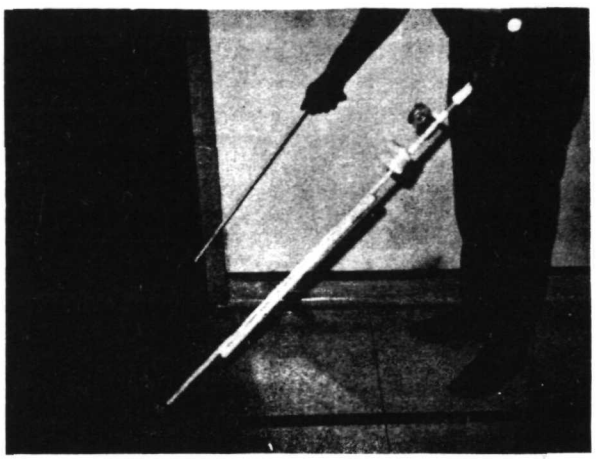
Dr. Ray Henke, Director
SRS Education Program
Stephen. F. Austin State University
Nacogdoches, Texas 75961

Mr. Robert Boudreaux
Department of Rehab. Science
U.T. Southwestern Medical School
5323 Harry Hines Boulevard
Dallas, Texas 75235

---*News from NASA*
continued from page 2

Blind individuals do not have at their disposal an economical cane which can be used by them to "track" a previously laid out course, as a means of providing a greater measure of self-sufficiency.

The more sophisticated canes developed as aids to the blind (laser canes, ultrasonic devices, etc.) are not within the economic reach of the typical visually handicapped individual.



A more economical, effective alternative is being developed by NASA for use in rehabilitation centers, homes for the blind, etc., where the number of blind persons present make it worthwhile to lay out a guidance track.

By adapting a cane to include the optical sensor used in the NASA sight switch, it is possible to have an effective tracking-sensing system which meets the needs as described above.

"Imagination IS more important than knowledge."

Albert Einstein

"Imagineering" - Let your imagination soar; then engineer it down to earth.

Alcoa

HOUMA DAILY COURIER
Houma, Louisiana

VR CENTER CONTINUES EXPANSION PROGRAM

The Terrebonne Vocational Rehabilitation Center here—a small part of the total Vocational Rehab picture in the Houma area — was a torchbearer in 1965 when it became the first of its kind in the nation wherein a school board was a third party entering into a contract with the Department of Education and the federal government to set up a rehab program.

The center is a cooperative agreement between the Louisiana State Department of Education, Division of Vocational Rehabilitation and the Terrebonne Parish School Board. It is designed to evaluate work habits, provide work conditions, and foster personal and social adjustments for boys and girls 16 years of age or older who have unique learning abilities or difficulties.

Eligibility for admission is governed by (1) the presence of a physical or emotional disability resulting in some functional limitation activity, (2) the existence of some substantial handicap to employment, (3) a reasonable expectation that Vocational Rehab can overcome the handicap and prepare the client to engage successfully in some remunerative occupation, or, worded more simply, a paying job, and (4) final passage by the admissions committee for the center.

In all cases, the clients in the center must be Vocational Rehabilitation clients before the machinery for TVR placement is put into motion.

Ultimately, its goal is remunerative employment through a well-defined program of evaluation, instruction, and projects. Or, as education Superintendent William Dodd phrased it, ". . . to make them become taxpayers instead of tax consumers."

The administration of the center is itself rather unusual. It is administered jointly between both parties, Vocational Rehabilitation and the Terrebonne Parish School Board.

Post
Houston, Texas

Institute opens annex for care of disabled

The Texas Institute for Rehabilitation and Research opened a new annex unit Monday with predictions from many that it will become a model for more meaningful care of handicapped patients.

Located at the corner of Drew and Albany Streets, the new building is divided into an 18-bed residential care unit and an 18-bed intermediate care program.

The institute bought the building in late 1970 from the Lorraine Priester Foundation, which originally planned to use it for a respiratory diseases center.

The building has been equipped to meet the special living needs of disabled individuals, with emphasis on accommodations for severely handicapped persons who are wheelchair-bound.

Institute officials said the residential care unit is the first of its type in the nation and should help with future plans for housing designed just for handicapped persons.

"I think it's the most exciting place I've ever seen for disabled people," observed Rodney Shaw, a former institute patient who will serve as residential unit manager.

Shaw, a senior psychology student at the University of Houston, said some of the unit's first 10 residents formed a non-profit corporation to help operate the pilot project under overall institute guidance.

Some local, state and federal agencies are being asked to provide supporting rehabilitation, vocational and financial services to the patients.

Shaw said eight of the 10 residents are University of Houston students who are trying to "make it" independently and who want to live on their own as much as they can.

The residential portion of the annex is a cross between a small apartment and a college dormitory and features built-in cabinets and shelves at wheelchair height.

The intermediate care section will provide services for patients in advanced stages of rehabilitation and who require only a minimum of medical attention.

Transportation as needed will be arranged to take annex residents and patients to the institute's main headquarters in the Texas Medical Center.

As Shaw explains it, the entire annex is set up to motivate the patients to return to economically independent lives as quickly as possible.

The Texas Institute for Rehabilitation and Research Auxiliary donated $9,500 to help get the residential care open.

Among officials participating in an opening day ribbon-cutting ceremony Monday were Dr. William A. Spencer, institute director; Charles Rathbun, president of the institute's board of trustees; Dr. R E. Carter, patient care director, and Mrs. Liz Bugower, auxiliary president.

TEX

FIRST IN NATION

DALLAS PD INSTALLS COMMUNICATIONS AID FOR DEAF

(Editor's Note: The following ar is reprinted from the December 7, . editions of THE DALLAS TI HERALD.)

The Dallas Police Department T day became the first in the natio establish emergency communications the deaf.

In cooperation with the Dallas Co for the Deaf, the department inst a two-way teletype machine in the patcher's office equipped to receive from deaf residents of the metropo area.

Approximately 45 deaf persons Dallas, Irving, Mesquite and Oak now have these machines," said Prestien, past president of the co and prime mover in building the "D TTY Network."

"We began about a year and a ago with three machines. My daug who is deaf, had one and two fri had the others,"he said.

"From that beginning the TTY work has grown tremendously. Nov those using the teletypes can call other just as normal people use phone. With the Police Department ed we gave them extra protection."

Largely through Prestien's eff Western Electric and Western U give the deaf discarded teletype chines. Each is being rebuilt by D K. McGinnis, an LTV engineer charges only for the cost of parts.

Each teletype installation costs a $150, says Prestien. The service is to approximately 1,000 deaf person the area.

To call police the deaf simply an unlisted number. The dispatcher's fice handles it as promptly as a phone request for aid.

The machines, equipped with a c ling device which permits the wri word to be transmitted over telepl lines, are sold at a reduced rate. police department says for the sp line for the deaf, the deaf person only the usual monthly telephone

OPEN SESSION

This is YOUR space -- reserved for your ideas and innovations. Send us your questions, your advice and your suggestions.

Editor

OKLAHOMA --

The Oklahoma Driver Training Course reported in the October, '71 issue of Research Utilization Report is available to clients in all states in Region VI. For information concerning this training, contact:

Mr. Arvel W. Houser, Supervisor
Rehabilitation Services
Department of Institutions, Social and Rehabilitation Services
P.O. Box 106
Central State University
Thompson Building
Edmond, Oklahoma 73034

TIRR --

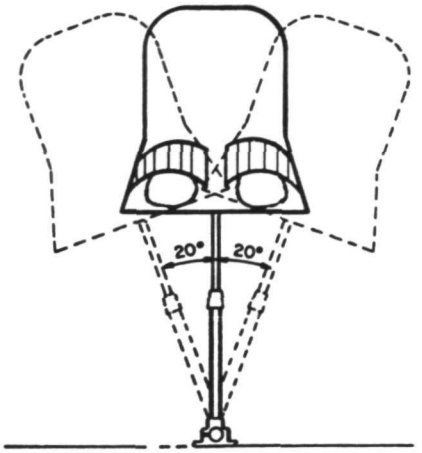
Additional information from Dr. Lewis A. Leavitt on the "Universal Harness" for above-knee amputees has been received. TIRR would like the opportunity of working with your amputee clients as early as possible in their rehabilitation program.

It is possible to fit the client with a preparatory prosthesis approximately two weeks after surgery. The individual can be ambulatory in three weeks.

For additional information please write:

Dr. Lewis A. Leavitt, Chairman
Department of Physical Medicine
TIRR, Texas Medical Center
1333 Moursund Avenue
Houston, Texas 77025

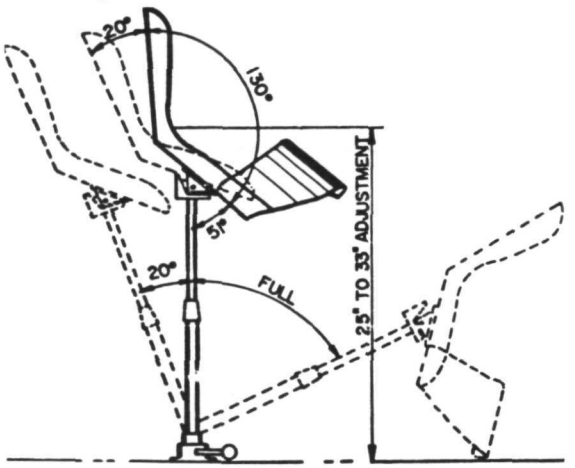
NASA -- **Restraint Support**



This device was developed to enable an astronaut to work comfortably with a minimum of restrictions in a weightless environment.

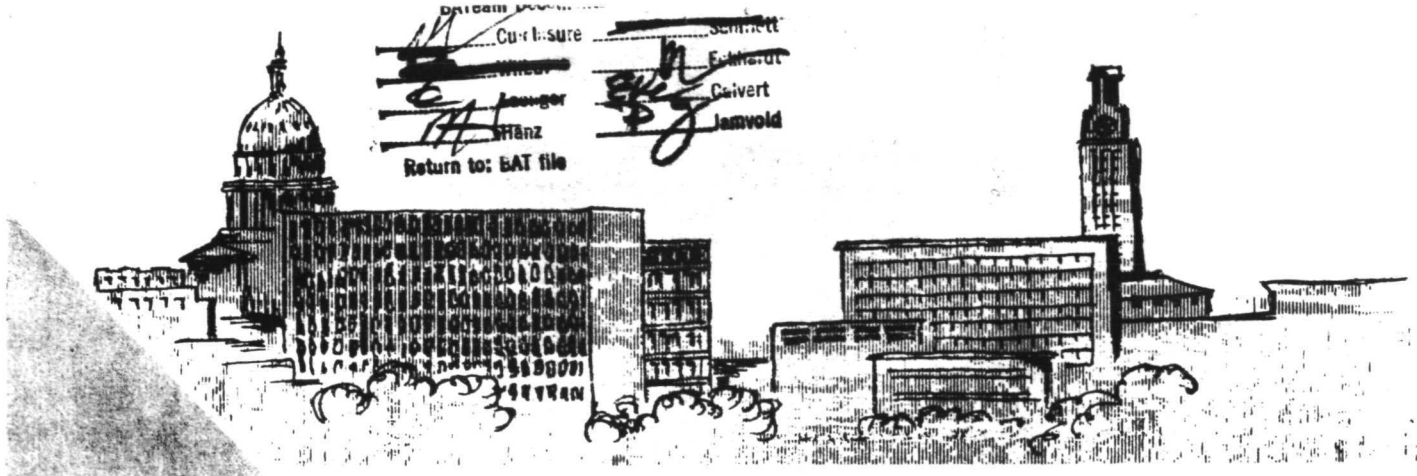
The design allows almost any movement. In a virtually erect position an individual can react quickly in any direction yet remain relaxed as if sitting in a chair.

This can be available for the handicapped worker where fatigue is a limiting factor. Do you have a client who might benefit?



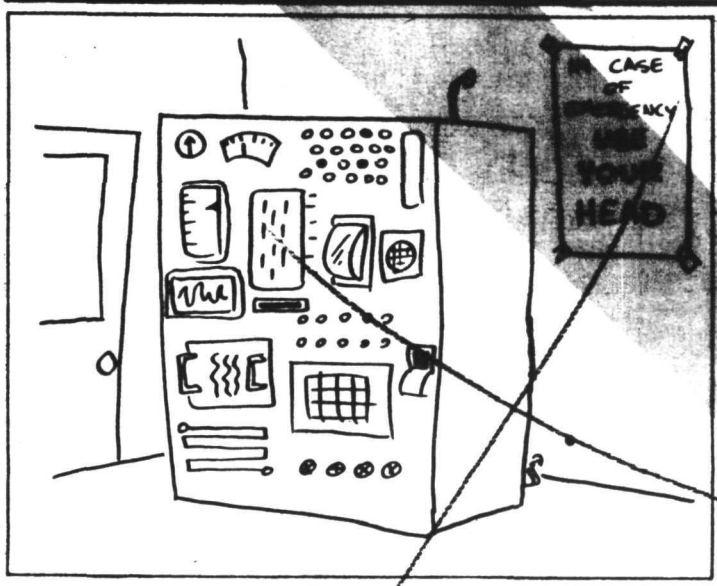
High Mobility Work Station

**Write--Mrs. Anne T. Kohler, RUS*
Texas Rehabilitation Commission
1301 West 38th St., Austin, Texas 78705



RESEARCH UTILIZATION

Vol. 2, No. 1 TEXAS REHABILITATION COMMISSION January, 1972



In this age of uncertainty, tight money, changing policies, wage freezes, and ever pending strategies there is still another bond we share.

Take comfort in the coming NEW YEAR and know that technology has provided a common denominator for all mankind--a system through which we are bound together in brotherhood.

In this computer age we are developing stronger personalities with understanding, patience and empathy for one another not previously experienced.

Through this bond of unity the goal of the Research Utilization Report is to represent the five states in Region VI with as much relevant information as possible.

We solicit your participation in the coming year. Send your articles, new clippings and ideas to Mrs. Anne T. Kohler, Research Utilization Specialist Region VI.

Texas Rehabilitation Commission
1301 West 38th Street
Austin, Texas 78705

HAPPY NEW YEAR TO EACH & EVERY ONE!

Jess M. Irwin, Jr.
Commissioner

INDEX

IV. INSTITUTIONS CURRENTLY UTILIZING SERVICES OF THE SOUTHWEST RESEARCH INSTITUTE BIOMEDICAL APPLICATIONS TEAM

Figure 57. Location of Institutions Using the Services of the SwRI Biomedical Applications Team.

M.D. Anderson Hospital
Houston, Texas

Arkansas Enterprises for the Blind, Inc.
Little Rock, Arkansas

Baylor University Medical Center,
Jonsson Hospital
Dallas, Texas

Baylor University Medical School
Houston, Texas

Brooke General Hospital
Ft. Sam Houston, Texas

Callier Hearing and Speech Center
Dallas, Texas

Caruth Memorial Rehabilitation Center
Dallas, Texas

Children's Convalescent Hospital
Oklahoma City, Oklahoma

Children's Hospital of Los Angeles
Los Angeles, California

Community Mental Health Service
San Diego, California

Criss Cole Rehabilitation Center
for Blind
Austin, Texas

Doheny Eye Foundation
Los Angeles, California

Fitzsimmons General Hospital
Denver, Colorado

Gallup Indian Medical Center
Callup, New Mexico

General Rose Hospital
Denver, Colorado

Hollywood Presbyterian Hospital
Los Angeles, California

Hot Springs Rehabilitation Center
Little Rock, Arkansas

Huntington Memorial Hospital
Pasadena, California

Loma Linda Medical Center
Loma Linda, California

Los Angeles County Hospital
Los Angeles, California

Mercy Hospital
Birmingham, Alabama

Morton Cancer and Research Hospital
Dallas, Texas

Rancho Los Amigos Hospital
Downey, California

Rosewood General Hospital
Houston, Texas

St. Josephs Hospital
Phoenix, Arizona

Social Security Disability Insurance
Texas Rehabilitation Commission

Scott and White Hospital and Clinic
Temple, Texas

Texas A&M University
College Station, Texas

Texas Association for Retarded Children

Texas Rehabilitation Commission
Austin, Texas

Texas Institute for Rehabilitation and Research
Houston, Texas

University of Alabama Medical School
Birmingham, Alabama

University of Arizona Medical School
Tucson, Arizona

University of Florida
Gainesville, Florida

University of Iowa Medical School
Iowa City, Iowa

University of Oklahoma Medical School
Oklahoma City, Oklahoma

University of Southern California Medical School
Los Angeles, California

University of Texas
Houston, Texas

University of Texas Medical Branch
Galveston, Texas

University of Texas Medical School
San Antonio, Texas

University of Texas Southwestern Medical School
Dallas, Texas

University of Utah Medical School
Salt Lake City, Utah

University of Washington Medical School
Seattle, Washington

University of Wisconsin
Madison, Wisconsin

Veterans Administration Hospital
Albuquerque, New Mexico

Veterans Administration Hospital
Bye Pines, Florida

Veterans Administration Hospital
Birmingham, Alabama

Veterans Administration Hospital
Denver, Colorado

Veterans Administration Hospital
Gainesville, Florida

Veterans Administration Hospital
Long Beach, California

Veterans Administration Hospital
Memphis, Tennessee

Veternas Administration Hospital
Sepulveda, California

Veterans Administration Hospital
Shreveport, Louisiana

Veternas Administration Hospital
Temple, Texas

Veterans Administration Southern
Research Support Center Hospital
Little Rock, Arkansas

Vocational Rehabilitation, State of
New Mexico
Los Cruces, New Mexico

Western Research Support Center
Sepulveda, California

Wilford Hall Hospital
Lackland Air Force Base, Texas

V. APPLICATIONS ENGINEERING ACTIVITY

The following problems were nominated for consideration as candidates for applications engineering. Under this program, selected items of NASA technology are subjected to modifications designed to render them more appropriate for a particular application. Of special interest are the Southwest Research Institute Biomedical Applications Team's in-house application engineering activities. Here, NASA technology which has been identified as a potential solution to a biomedical problem is adapted to fit the specific needs of the individual researcher by BATeam engineers, in-house, thus expediting the application of aerospace technology to the medical field.

Problem Number	Title	Status
UAM-11	Ultra Low Frequency Band Pass Amplifier	Prototype unit fabricated and delivered to the problem originator.
GLM-35	Beta Radiation Catheter Probe	Prototype unit fabricated and evaluated sucessfully in in vivo testing by the Problem Originator
SWC-2	Instrument for Measurement of Evoked Cortical Response	Prototype unit being fabricated and tested at Marshall Space Flight Center
SWC-12	Detection of Eye Tumors by Use of Radiation Probes	Project completed. Unit delivered to Problem Originator.
RRC-2	Accurate Cardiac Telemetry from Active Subjects	Prototype unit fabricated and delivered to the Problem Originator.
UAM-1	Capacitative ECG Electrodes	Prototype units being fabricated at SwRI.

Problem Number	Title	Status
RNU-37	Surgically Implantable Nerve Stimulator	Work has been deferred until alternative approaches which have come to light can be analyzed.
TCD-1	Portable Sound Meter for Use by Deaf	Prototype unit fabrication completed and tested sucessfully by the Problem Originator.
BVA-4	ECG Telemetry Reciever and Chart	AE candidate not approved by TAD NASA.
TCD-2, 3	Warning System for use by Deaf	Prototype unit being fabricated at Langley Research Center.
TCB-16	New Type Tracking Cane for Use by Blind	Prototype unit fabricated.
CMR-1	Improved Method for Hanging Wastes from Colostomy Patients	Prototype unit fabrication beyond the scope of available team resources. AE candidacy has been withdrawn.
BVA-1	X-Ray Transparent Electrodes and Leods	Prototype electrodes being fabricated.
OVA-2	Measurement of Lung Compliance	Awaiting approval as an Applications Engineering candidate.
GLM-5	Intercranial Pressure Telemetry System	Unit fabricated and delivered to the Problem Originator.
TVA-2	Portable Heart Rate Indicator for Active Patients	Awaiting approval as an Applications Engineering candidate.

Problem Number	Title	Status
AEB-1	Method for Identifying Denominations of Paper Money	Initial design work in progress.
NMV-1	Control System to Permit Quadriplegics to Operate Long Playing Recording Devices	Awaiting approval as an Applications Engineering candidate.

VI. CONCLUSIONS AND RECOMMENDATIONS

Importance Of The Interpersonal Communicative Process

During the reporting period, the team placed continuing emphasis upon developing improved techniques for facilitating the transfer of aerospace-related technology to biomedical researchers and practitioners particularly in the area of rehabilitation medium. A considerable portion of this effort was in the direction of motivating these individuals to take advantage of the program. The team utilized, among others, such techniques as writing personal letters which outlined the program and its goals, following up the letters with personal visits; presenting formal seminars to investigators assembled for this purpose at selected institutions; scheduling individual conferences with investigators to acquaint them with the general nature of the program; and preparing displays and exhibits for presentation at selected professional conferences and meetings. Each technique appears to play a useful role in helping the team generate investigator interest in the technology utilization program.

Motivational Considerations

The team has faced a continuing problem in motivating researchers and practitioners in the biomedical community to:

(1) Use the program,

(2) Evaluate potential aerospace technology application solutions on a timely basis, and

(3) Provide needed minimal feedback regarding utility of offered solutions.

There is some prospect that the first problem-getting the researcher to use the program-will be aided materially as the potential offered by the technology utilization becomes better recognized by the biomedical community. Greater visibility afforded the program by (1) the press release efforts undertaken by the Technology Utilization Division; (2) articles which have appeared in national medical journals; and (3) proposed displays to be erected by NASA in air terminals across the nation. These will all aid in getting the technology utilization message across to potential users. However, the last two considerations continue to constitute a considerable source of difficulty. They inject significant time delay in achieving technology applications. Improved follow-up surveillance of active problems is being undertaken to reduce the delay and stimulate the investigator to follow through. This interaction includes provision of consultation and engineering assistance in developing means for employing the suggested aerospace technology

in solving the investigator's problem. A serious problem exists in terms of encouraging industry to assume the responsibility for making innovations developed under the program available to those who need them. New mechanisms are needed to induce industry to take an active role in the technology utilization process.

Need For Improved Interaction With NASA Researchers

Development of improved techniques for more adequately tapping the expertise available within NASA research facilities continues to be a matter of prime concern. This is because a large amount of technology remains in the minds of NASA engineers or scientists, never appearing in a technical paper or report, which have been the mainstays of the problem solution effort. More extensive and effective interpersonal interaction is clearly needed to capitalize upon this valuable asset. To this end, the team proposes to station a team member at the lead center for biomedical activities, for full time duty. This will facilitate development of the interaction needed with resident scientists and engineers.

Need For Program Participation By Other Governmental Agencies

Most of the innovations developed under the technology utilization program have the characteristics of (1) being related to some aspect of medicine being researched using government funds and (2) being small in terms of market potential. On the one hand, the program can be of considerable assistance to recipients of government research grants in helping solve technological problems which might be impeding their research endeavor - if the team is made aware of the problems; on the other hand, the government research sponsors can be of considerable help to the technology utilization program in terms of helping develop a aggregate marked for program end-items. For example, the patient assist system is in great public demand. However, the potential market is not sufficently large to induce industry to take on manufacturing and marketing of the system without some guarantee of a minimum market. Both the Veterans Administration and Social and Rehabilitation Service have an internal need for a substantial number of the systems. Should these agencies present their aggregate requirements to industry, there is little doubt but that a manufacturer would be found who is willing to market the system - not only to the government, but also to the biomedical community at large.

APPENDIX A
PROJECT ACTIVITY SUMMARY

POTENTIAL TECHNOLOGY APPLICATIONS IDENTIFIED

SWC-12	Detection of Eye Tumors by Use of Radiation Probes
RRC-8	Ultra-thin Electromyographic Needles
FTZ-1	On-Line Breath Analyzer
OVA-2	Measurement of Lung Compliance
SWC-2	EEG Audiometric System for Use with Infants
BVA-1	X-Ray Transparent Electrodes and Leads
OVA-4	Method for Assessing Sleep Pschyophysiology in Extreme Environments
RNV-37	Surgically Implantable Peroneal Stimulator
OCH-1	Lightweight Long Leg Braces for Children
BLM-11	On-Line Biochemical Analysis of Samples Collected Automatically from Patients
BLM-11a	On-Line Biochemical Analysis of Samples Collected Automatically from Patients
RNV-34	Pressure Sensitive Device for Use in Tongue Operated Control System
SJH-1	Interfacing Biochemical Analyzers with a Computer
SJH-2	Interface Schematics for Incorporation into Biomedical Analyzers
UAM-11	Ultra-Low Frequency Bandpass Amplifier for Gastro-intestinal Electric Potentials
BVA-4	Portable ECG Telemetry Receiver and Chart Recorder
OVA-5	Nonencumbering EEG Electrode Assembly Suitable for Long Term Sleep Research Application
UTM-37	Tendon Repair Device
RRC-2	Accurate Cardiac Telemetry from Active Subjects

POTENTIAL TECHNOLOGY APPLICATIONS IDENTIFIED

TCB-1	Remotely Activated Switch for Use by Blind to Activate Power Tools
HSR-7	Improved Control Mechanisms to Expand Self-Sufficiency of Ouadriplegics (Patient Assist Device).
GLM-5	Intracranial Pressure Measurement System
UAM-8	Electrical Safety Standards for Hospitals
GLM-35	Beta Radiation Catheter Probe
WLH-2	Device to Clini cally Evaluate Nasal-Airway Obstructions
TCB-7	Portable Light Detector System for the Blind
TCD-2	Warning System for the Deaf
TCD-1	Portable Sound Meter for Use by Deaf Persons
TCD-9	Portable Voice Amplification System for Individuals w/partially paralyzed vocal cords
TCB-16	New Type of Tracking Cane for the Blind
CLA-3	Respiration (Apnea) alarm for Infants
SWR-1	Custom Fitted Composite Leg Brace

CURRENTLY ACTIVE PROBLEMS AS OF AUGUST 1972

Problem Number	Status Code	Problem Title
AEB-1	A	Method for Identifying Denominations of Paper Money
AEB-2	A	Measurement of Physiologic Stress Parameters
AEB-3	A	A Light Sensitive Vocation Rehabilitation Aid
AVA-2	D	Carotid Artery Pressure Waveform Measurement
BLM-10	D	Computer Programs and Systems for Analysis of the ECG
BLM-13	E	Nonthrombogenic Material For Use as a Blood Interface
BLM-17	B	Improved Procedures to Measure Regional Blood Flow in Kidney
BLM-25	D	Simple Economical Mass Screening Techniques for Analysis of EKG in Clinical Diagnosis and Multiphasic Health Screening
BMC-1	C	Attraction-Movement of Non-Magnetic Material
BMC-4	D	Improved Arch Support Material
BVA-1	E	X-Ray Transparent Electrodes and Leads
BVA-4	E	Portable ECG Telemetry Receiver and Tape Recorder
BUD-1	D	Heat and Stress Resistant, High strength Plastic for Fabrication of Orthotic Devices
CHS-3	D	Multiple Electrode Stimulation of the Cochlea
CHS-5	D	Flexible Interface with Auditory Brain Centers

Problem Number	Status Code	Problem Title
CHS-7	D	Auditory Center Brain Implant Electrode
CHS-10	D	Hearing Aid Malfunction System
CHS-11	D	Artificial Eye Lens
CHS-12	D	Dipole System Auditory Multichannel Stimulation of the Brain
CHS-14	D	Magnetic Stimulator for Deaf-Blind Patients
CLA-3	E	Alarm Circuitry for Apnea Telemetry
DLM-14	C	Detection of Kidney Stones During Surgery
FTZ-1	E	On-Line Breath Analyzer
FTZ-2	D	Invasive Means for Measuring Blood Gases
GLM-5	E	Intracranial Pressure Telemetry System
GLM-32	B	ECG Preamplifier For Home Tape Recorder
GLM-35	E	Beta Radiation Catheter Probe
GLM-37	D	Activity Telemetry from Single Neurons in Aquatic Animals
GLM-39	B	Artificial Speech Synthesizer
GLM-40	B	Telemetry from Divers
GLM-41	B	Electrodes to measure Potentials of the Cochlea and VIII Nerve Action
GLM-42	B	Automatic Interruptor of Speech to Separate Words by Phonemes During Tape Recordings
GLM-43	B	Quick Attachment/Release Clamp
GLM-44	D	Quickly Adjustable Crutch
GLM-45	E	Material for Water Stretcher
GLM-46	F	Adjustable Cradle to Cover Burned Patients

Problem Number	Status Code	Problem Title
GLM-47	B	Improved Stretcher Design
GLM-48	B	Ceiling Attachments in Hydrotherapy Room
GLM-49	B	Monorail Patient Transport System
GLM-50	F	Catheter Support for Rehabilitation Patients
GVA-6	D	Respiration Monitor
HPH-1	D	Particle Detector Monitor for Cleam Room Surgery
HSR-1	E	Impression Material for Making Pattern of Lower Trunk
HSR-2	E	Resilient, Breathing Contour Seat Material
HSR-6	E	Sight Switch Operated Prehension Device
HSR-7	E	Improved Assist Device Expands Self-Sufficiency Potentials for Quadriplegics
HUV-20	D	Perceptual Motor Testing of the Severely Disabled
HUV-22	D	Automobile Driving Assist for Triplegic
HUV-23	B	Automatically Operated Magnetic Tape Cassette Recorder
IOU-1	B	Method for Measurement of the Amount of Humidity Present in the Lower Respiratory Tract
LLU-10	D	Non-Invasive Techniques for Measuring Oxygen Content in Blood
LVA-3	D	Radioactive Microcell Counting Techniques for Diagnosis and Treatment of Leukemic Disorders
LVA-5	D	Device for Weighing Laboratory Rats
LVA-6	D	Method for Measuring Temperature of Laboratory Rats in Isolation Chambers

Problem Number	Status Code	Problem Title
LVA-7	D	Method for Acquiring ECG Information from Laboratory Rats in Isolation Chambers
MHB-1	D	Outpatient Clinic Computerization for County Hospital
MHB-2	D	Computer Programs for Health Care Improvement
MHH-1	E	Rapid Identification of Surgical Instruments
MVA-2	B	Measurement and Recording of Urine Flow
NMA-1	D	Program to Establish Electrical Safety Standards for Equipment and Instruments Used Around Patients
NMA-3	B	ECG Cable Take-Ups for a Portable ECG Monitor in an Intensive Care Unit
NMA-10	D	Video Tape Programming for Speech Therapy
NMA-12	B	Sauna Bath Conditions Monitoring
NMV-1	D	Control System to Permit Quadriplegics to Operate Long Playing Recording Devices
NUM-1	A	Methods for Interpreting Ultrasonic Doppler Blood Flow Velocity Signals
NUM-2	A	Measure Diameter of Femoral Artery by Ultrasonic Pulse-Echo Method.
OCH-1	E	Plastic Long Leg Braces for Children
OCH-5	B	Failure Resistant Cerebrospinal Fluid Shunt
OCH-6	B	Sensory Hemiplegiac Stimulator
OCH-7	B	Work Space for Upper Extremity Amputee
OVA-2	E	Measurement of Lung Compliance

Problem Number	Status Code	Problem Title
OVA-4	E	Assessing Sleep Psychophysiology in Extreme Environments
OVA-5	E	Non-encumbering EEG Electrode Assembly
PPR-1	B	Home Paging System for Reminding Elderly Patients of Medication Times
PVA-3	D	EEG Analysis Computer Programs
PVA-4	D	EEG Electrode Holders
PVA-5	D	Low Noise EEG Preamplifiers for Clinical Research
PVA-6	B	Band Pass Filtering for EEG Alpha Signals
RNV-32	D	Measurement of Energy Expended in Walking
RNV-34	D	Pressure Sensitive Device for Use in Tongue Operated Control Systems for Artifical Organs and Wheelchairs
RNV-37	D	Surgically Implantable Nerve Stimulator
RNV-38	D	Design Techniques for Making D.C. Motors for Powered Orthotic Devices
RNV-39	B	Development of Proper Procedures and Observation of Human Subjects in Medical Research
ROS-1	D	Constant Velocity Vehicle for Small Laboratory
ROS-2	D	Method for Measuring Blood Gas Without Breaking the Skin
RRC-1	B	High Energy Cost Exerciser with Ergometric Monitor
RRC-2	E	Accurate Cardiac Telemetry from Active Subjects

Problem Number	Status Code	Problem Title
RRC-6	B	Lightweight, Portable Cushion Seat Jack for Weak or Paralyzed Patients
RRC-7	B	Oscilloscope Synchronization for Electromyographic Needle Manipulation
RRC-8	E	Ultra Thin Electromyographic Needles
RRC-9	D	Automatic Locking Prosthetic Leg
SJH-1	E	Interfacing Biochemical Autoanalyzers with a Computer
SJH-2	D	Interface Schematics for Incorporation of Biochemical Autoanalyzers to a Computer
SNM-13	D	Miniature pH Electrode for Fetus
SNM-14	D	Fetal ECG Telemetry
SNM-15	D	Uterine Pressure Telemetry
SNM-24	D	Brain Resistance and Impedance Changes Under Anesthesia
SNM-25	B	Development of an In Vivo Blood Glucose, pH and pO_2 Analyzer
SNM-26	B	Monitoring of Pelvic Pressure of Women During Labor
SWC-2	E	Cortical Audiometry Measurements
SWC-6	B	Apparatus for Micropuncture of Pancreatic Gland
SWC-13	D	ECG Data Compression Techniques
SWR-1	D	Custom Fitted Composite Leg Brace
TAM-1	D	Direct Skeletal Attachment of Prosthetic Devices
TAR-1	D	Epileptic Seizure Warning Device

Problem Number	Status Code	Problem Title
TCB-1	E	Remotely Activated Switch for Electrically Operated Saw
TCB-2	C	Blind Person Guidance Detector of Impregnated Paint or Wire Boundary Market
TCB-4	B	Non-Magnetic Homing Device for use by Blind Persons
TCB-5	B	Acoustic signal alerts Blind typist of approaching end of page
TCB-16	E	New Type of Tracking Cane for the Blind
TCB-17	B	Acoustic Signal to Alert Blind Persons to Obstacles between the Waist and Head
TCB-18	B	Permanent Reflective Coating for Use on Canes for the Blind
TCB-19	B	Navigation Assistance to Keep Blind on a Set Direction of Travel
TCD-1	E	Portable Sound Meter for Use by Deaf
TCD-2	E	Warning System for Use by Deaf
TCD-3	E	Portable Substitute for Door/Telephone Bell for Deaf
TCD-4	B	Noise Activated Flasher Warning for Deaf Driver
TCD-5	B	Speech Analyzer
TCD-9	E	Portable Amplifier System for Patient with Partially Inactivated Vocal Cords
TCH-1	B	Quantification of Biochemical Changes in Striated Muscle Due to Inactivity
TCM-3	B	Peak Detector for Signal Conditioning of Blood in Basic Medical Research
TPR-1	D	Electro-Sleep Electrodes

Problem Number	Status Code	Problem Title
TPR-2	B	Device to Correct Foot Pronation
TVA-2	B	Portable Heart Rate Indicator for Active Patients
UAD-1	D	Tooth Movement Sensor
UAD-2	D	Tooth Position Within the Socket
UAD-3	D	Determination of Tooth Vitality
UAD-4	D	Tooth Vitality Measured by Nerve Condition
UAD-5	D	Preparation of Dental Material Samples for Microscopic Analysis
UAD-6	D	Microhardness Analysis of Tooth Enamel
UAD-7	D	Telemetry of Oral pH for Determination of Linkage to Cavity Formation
UAM-1	E	Capacitative ECG Electrodes
UAM-2	D	Heart Sounds Telemetry
UAM-3	B	Implantation Techniques for Chronic Measurements of Physiological Data
UAM-5	B	Study of Cell Fluorescence by TV under Low Light Intensity Conditions
UAM-8	D	Electrical Safety for Hospital Patients
UAM-12	B	Cardiovascular Dynamics Models
UAM-13	B	Flexible Oral Transducer Matrix
UAM-14	B	Self-Propelled Experimental Cart
UAM-15	B	Programmer Oxygen Consumption Meter
UAM-16	B	Cassette Recording and Display of ECG, Pulse Rate, and Oxygen Consumption

Problem Number	Status Code	Problem Title
UAM-17	E	Respiration Face Mask
UAM-18	E	AK Prosthesis Fabricated from Composite Materials
UFM-6	D	Xeroradiography of Mammary Glands for Cancer Detection and Multiphasic Health Screening
UFM-7	D	Methods for Computer Analysis of EEG for Health Care Cost Reduction
UOF-2	B	Low Level Non-Invasive Blood Pressure Measurement
UOF-3	B	Detection of Schools of fish in pollutant studies
UOF-4	B	A method for determining blood coagulation by Phonocardiography
UOW-1	B	Improved Eye Switch Control for Use by Totally Paralyzed Cerebral Palsy Patients
USC-9	D	A Tactile Projector for Teaching Blind Students
UTH-1	D	A Tactile Projector for Teaching Blind Students
UTM-1	D	Physiologic Data Handling - Systems Approach
UTM-24	E	Photo-Etched Form to Cast Artificial Kidney Matrix
UTM-25	B	Ionizing Radiation Detection of Thrombogenesis
UTM-27	D	Miniature Mosaic TV Camera
UTM-30	D	Biocompatible Bone Interface for Prostheses

Problem Number	Status Code	Problem Title
UTM-31	D	Plastic Prosthetic Materials
UTM-32	B	Improved Design for Foot Supports
UTM-33	D	Form-Fitted Foot Pad Brace
UTM-34	B	Lining Absorbs Pressure and Friction Forces
UTM-35	B	Lightweight Long Leg Braces
UTM-36	D	Artificial Heart Transducer
UTM-37	E	Butt-Welded Fine Gage Wire
UTM-38	D	Improved Urethral Valve for Nonsurgical Implantation
WLH-2	B	Device to Clinically evaluate Nasal-Airway Obstructions
WLH-3	D	Elasticity in Long Bones to Determine Optimum Fracture Knitting Condition
WLH-4	B	Myoelectric Powered Prosthesis

CURRENTLY ACTIVE PROBLEMS
STATUS CODE DEFINITIONS

A. Problem Definition

Problem definition includes the identification of specific technology-related problems through discussions with biomedical investigators and the preparation of functional descriptions of problems using nondisciplinary terminology.

B. Information Searching

Information relevant to a solution is being sought by computer and/or manual information searching.

C. Problem Abstract Dissemination

An information searching has revealed no potential solutions and a problem abstract is being circulated to individual scientists and engineers at NASA centers and contractor facilities to solicit suggestions.

D. Evaluation

Potentially useful information or technology has been identified and is being evaluated by the team and/or the problem originator.

E. Potential Technology Application

Information or technology has been evaluated and found to be of potential value but has not been applied.

F. Follow-Up Activity

Useful information has been identified, but further activity (ie., documentation, obtaining experimental validation of utility, continuing modification, etc.) is required.

APPENDIX B

ACTIVE PROBLEMS ACCORDING TO HEALTH AREAS

PROBLEM BLM-25 Simple Economical Mass Screening Techniques for Analysis of ECG in Clinical Diagnosis and Multiphasic Health Screening

The researcher at a southwest medical institution requires an inexpensive technique for detecting latent heart disease by automatic analysis directly from the patient's heart electric signal (ECG). This will permit implementation of a large-scale, multiphasic health screening program. The method and device must be economical, reasonably portable, adaptable to a minimum number of trained staff personnel, and reliable for mass screening procedures. The NASA real-time analysis of astronaut and spacecraft functions technology may perform ideally in this application.

PROBLEM UFM-7 Method for Computer Analysis of EEG for Health Care Cost Reduction

Researchers at a hospital are attempting to mass-screen patients as a community service to determine which patients require further medical attention and identify needed medical help areas for each patient. Computer analysis of EEG recordings is desired to reduce costs and increase speed.

PROBLEM SWC-2 Instrument for Measurement of Evoked Cortical Response

Infants and preschool children may exhibit characteristic retardation symptoms. Many of them have been diagnosed as suffering from brain damage when their problem is deafness or a hearing defect. These children are unable to accurately speak or respond to ordinary hearing tests. Accurate methods are needed for the doctor to determine if there is a hearing defect or if there is brain damage. Concise, properly diagnosed treatment can be administered to bring deaf children to the intellectual level of their peers during years 1 to 6, the most formative years.

The researchers have constructed a device illustrating the feasibility of discovering hearing defects in infants and young children. Problems encountered with the current system require so much attention that reliable data are difficult to obtain. Electrode and earphone attachments are difficult to maintain because the youngsters tend to knock them off. The proposed solution is described in Problem SWC-1 and involves incorporating a modified football- or baseball-type helmet into the final system. Electrode noise and cabling problems compound the first stage noise level of their biopotential amplifier. Problem SWC-9 provided a solution to this problem. There are other problem areas in the design for the instrument in operation. The unit is composed of cumbersome subassemblies. They require much switching,

knob twisting, and cabling. At least two people are involved in setting up the unit. The problem originator prefers to vary the rise time of the tone burst as indicated in a specification sheet. The existing circuitry does not permit this. Researchers at Marshall Space Flight Center have designed and are building a compact audiometry system to solve the problem.

PROBLEM BLM-10 Computer Programs and Systems for Analysis of the ECG

Identification of existing computer programs which provide automatic diagnostic interpretation of the electrocardiogram is needed. Portions of these programs are intended for adaptation to a small computer system to provide multiphasic health screening in multiple testing of large numbers of subjects. It should be economically feasible for clinical use.

REHABILITATION MEDICINE

PROBLEM CHS-10 Hearing Aid Malfunction Alarm System

The extremely fragile nature of hearing aids for very young deaf or deaf-blind children makes them subject to malfunction due to the hard usage factor. These children cannot readily communicate and their habilitation is primarily based upon retention and amplification of available residual sensory physiology that is present. The hearing aids need to work consistently for this habilitation to be most effective. A schedule of screening and rather crude testing is the only apparent solution presently available.

A miniature alarm system to give warning of any malfunctioning within the hearing aid of deaf or deaf-blind children is needed. The device should either sound or flash an alarm to alert the therapist of any malfunction in the amplification, the breakage of lead wire, or, if possible, also the distortion in quality of sound. The system should be miniature to be accommodating to the size and use of present hearing aid configurations and wearing constraints. It is essential for hearing aid devices to be in working condition to provide a basis for learning in a difficult environment for the child.

PROBLEM CHS-5 Flexible Interface with Auditory Brain Centers

Technological methodology and device for a flexible substrate and potting for solid state circuitry to be implanted in the brain is needed. The problem originator is one of a group who is researching to develop a means for stimulating the auditory centers of the human brain to provide an alternate means for hearing when inner ear anomalies, injuries or nerve damage prevents normal hearing. Electrodes have been implanted within the auditory centers of a cat in parallel studies of hearing stimulation. The substrate and potting

needed for the solid state circuitry implantation will be used to present a variety of waveforms telemetered from an artificial ear. Material must be biocompatible with brain tissue and fluids; it must be safe for use within the brain of humans; and it must be flexible to respond to the vibratory motions of the active, living brain to avoid tissue damage or irritation. This material should accept mounting of solid state circuitry.

PROBLEM HSR-6 Sight-Switch Operated Prehension Device

A simple, easy to operate, all-or-nothing, on-off switch is needed to operate a prehension device by a directed eye movement. The problem originator is one of a group providing care and treatment for paralyzed or amputee patients in habilitation and rehabilitation activities. Prehension devices have been developed to allow the patient capabilities for mobility and self-care. They require movements of the shoulder or torso musculature to control positioning and/or degree of pressure in prehension movements by an assist device. A simple, eye-movement controlled switch is felt to be the ideal answer to this problem.

NASA technology is available to solve this problem. An infrared eye switch developed to allow astronauts under high acceleration forces to manipulate control devices is applicable to the solution of the problem. This technology is presently being evaluated.

PROBLEM HUV-20 Perceptual Motor Testing of the Severely Disabled

The problem originators need methodology or devices to objectively measure the upper extremity capabilities of patients having varying levels of spinal lesion. A group of researchers are developing care and treatment for severely disabled patients in a rehabilitation hospital. The kinds and scope of vocational services for the patient largely depend upon the inherent residual capabilities present. Standard tests of manual dexterity cannot measure the needed parameters to thoroughly test the capabilities of spinal injury patients to care for themselves and perform various kinds of work activities.

The methodology and device must be able to measure reaction times and decision times, to partial out digit and forearm speed, and also to measure accuracy in one- and two-dimensional tracking tasks of various control orders. Effective measurement techniques are expected to enhance the return of severely disabled persons to a productive and independent life.

Two psychomotor performance measuring devices have been identified via aerospace literature searching. The technology is described in two NASA

Tech Briefs, B69-10385 "Improved Perceptual Motor Performance Measurement System" and B70-10619 "Human Performance Measuring Device." The second of these two instruments has been evaluated for rehabilitation applications by the problem originators.

PROBLEM RRC-6 Lightweight, Portable Cushion Seat Jack for Weak or Paralyzed Patients

Between four to five million people in the United States suffer from muscular weakness diseases as arthritis, rheumatism, paralysis (partial), muscular dystrophy, etc., and from debilities of old age. These individuals usually can walk around, but require assistance to rise from sitting positions in low chairs or car seats. They need a lightweight cushion which they can carry around with them and sit on with normal comfort. Assistance to help this person stand up by his own effort is urgently needed.

A simple, lightweight, inexpensive, easy-to-operate, portable cushion seat jack of novel spring or hydraulic control operation is needed for this purpose. These patients may not be able to perform squeezing hand movements and may require special handle considerations similar to those conceived for Moon cart.

PROBLEM RRC-8 Ultra-Thin Electromyographic Needles

Excessive pain is generated in the skin of patients who must be repeatedly exposed to skin punctures by an electromyographic (EMG) needle during evaluations of muscle and nerve damage (muscle electrical energy potential measurements). The pain appears to be closely associated with the gauge or thickness of the needle—thicker needles cause more pain. About 70 to 80 EMG studies each month are performed at this rehabilitation center. A biocompatible, electrical conductor alloy which can be used as an ultra-thin, insulated electromyographic needle is needed. It should be about 1-1/2 inches in length, should accept a very sharp point, should have flexure characteristics sufficient to resist bending of the shaft (warping) or of the point (fishhooking) to provide lateral stability, should be biocompatible for insertion through the skin into muscle tissue, and should accept a form of sterilization.

PROBLEM RNV-34 Pressure Sensitive Device for Use in Tongue-Operated Control Systems for Assist Devices and Wheelchairs

In the past two decades improved medical care has resulted in the survival of an ever-increasing group of patients with severe neuro-muscular disabilities who otherwise would have succumbed to their disease or remained bedridden. This has created a large population of severely paralyzed persons dependent upon society for care.

Although considerable progress has been made in the development of control systems for externally-powered orthotic devices for use with such persons, they continue to be the major limiting factor in the degree of function which can be attained. Extra-oral tongue-operated switch controls which provide sequential off-on control of the orthesis show great promise as a means of solving the control problem.

A small mechanical pressure switch is needed for placement within the oral cavity as part of a tongue-actuated control system for assist devices and wheelchairs. The switch should be reliable, resistant to deterioration caused by constant exposure to saliva, and small enough to fit the lingual area of the mandible so that pressure can be exerted by the tongue.

A possible solution has been identified (insulated-gate field-effect transistor which performs strain-sensing and amplification functions in one integral device). The technology is announced in NASA Tech Brief 70-10157.

PROBLEM TAM-1 Direct Skeletal Attachment of Prosthetic Devices

Devices and methodology to accommodate bone properties for the direct skeletal attachment of prosthetic devices to replace missing parts are needed. Preliminary *in vivo* and *in vitro* studies have been conducted on the mechanical properties of whole equine bones concerning effectiveness of various bone fixation devices. The reaction properties of bones to injury, implants, prostheses, etc., are needed to develop low-cost, effective, safe and reliable, direct skeletal attachment devices as replacements for missing limbs. Broad spectrum data tabulations are needed for research and development.

Devices and methodology must be safe for human use. Chemical, mechanical, electrical, and physical data are required with reference to the environment, activity workload, and nutrition variables. Bone-to-tendon attachment substitutions are essential to this problem.

A search of aerospace literature was done and forwarded to the problem originator. Pertinent information was retrieved by the search and is undergoing a more extensive evaluation by the problem originator.

PROBLEM BMC-1 Attraction-Movement of Non-Magnetic Material

A device is needed to attract and move non-magnetic foreign bodies invasively imbedded in eyeball vitreous humor.

The investigator is clinically treating patients who may have a variety of intraocular foreign bodies. The foreign bodies must be removed to prevent chronic irritation of the eye with attendant visual loss. If the foreign body is magnetic, it is relatively easy to attract and move the body through the vitreous humor (the viscous gel between the eye lens and retina) to an eyeball wall area or to the pupillary aperture, where it can be surgically extracted.

Non-magnetic foreign bodies are extremely difficult to move and surgically remove. Attempts to "scoop through" and "fish" them out usually are unsuccessful and sight is lost, with or without surgery.

Vitreous humor is a thick, stringy, sticky gel which must be "clipped" with scissors to remove it from surgically extracted bodies. Foreign bodies may consist of brass, aluminum, glass, plastic, cooper, lead, Vietnamese mud, and other particles.

PROBLEM NMA-12 Sauna Bath Conditions Monitoring

Sauna baths are given to selected overweight patients as part of the regimen to maintain general health conditions and reduce body weight. Patients individually react to the sauna bath heat and humidity and some develop serious distress. The problem originator is developing a means to recognize those in distress and remove them from the bath before they are detrimentally affected by monitoring physiological parameters and room conditions.

Devices should telemeter EEG, cardiac output, blood pressure, and body temperature of the patient as well as room temperature and dew point. Attachment and accuracy of transducers must be compatible with high sweat and high humidity under sauna bath conditions.

PROBLEM PVA-3 EEG Analysis Computer Programs

The problem originator is studying analysis of electroencephalograms by computer. Research is at the stage of evaluation and revision of design plans and a request has been received for comparative NASA technology.

PROBLEM HSR-1 Impression Material for Making Pattern of Lower Trunk

An interdisciplinary team at a southwest rehabilitation center is constructing bucket-style, contour chairs. They are used in the care and treatment of spinal cord injury patients, particularly quadriplegic patients. These patients traditionally have been confined to bed during most of their waking hours. When a specially fabricated contour chair is used, however, the patients can be permitted to sit up for extended periods. The researchers need material to more accurately, rapidly, and efficiently prepare impressions of the paralyzed patient's body.

Relevant technology has been retrieved to solve the problem. Methodology for fabricating a foam-in-place, form-fitting pilot's helmet liner directly on the pilot's head, shows good potential as impression material to make the

exact patterns for the lower trunk. Another interesting application of this foam system is consideration as a replacement for plaster of paris cast material for broken bones.

PROBLEM HSR-2 Resilient, Breathing Contour Seat Material

A research team at a southwest rehabilitation center is fabricating and using contour chairs for spinal cord injury patients. The investigators need materials for the contour seat of wheelchair patients. A rigid base material and a resilient, limited degree of cushioning material is needed. Samples of materials were provided since applicability must be determined empirically.

PROBLEM NMA-10 Video Tape Programming for Speech Therapy

Speech therapy at a Veterans Administration Hospital is an expanding program because of the large number of brain-injured Vietnam veterans. The problem originator is attempting to computerize some asepects of therapy to assist in reteaching speech. Insufficient therapists and assistants are available to handle this load. The problem originator strengthens oral signals with visual stimuli and needs programming techniques for video tapes including both video and audio signals.

PROBLEM TAR-1 Epileptic Seizure Warning Device

Technological methodology and device to detect the emanations and changes associated with onset of epileptic seizures are needed. Epileptics report onset of seizures are preceded by auditory and visual signals that can be recognized. These signals have been used in various ways by medical researchers to evaluate the cause and treatment of the medical problem. Therapy sometimes consists of advice and conditioning of the patient with respect to the individual onset warning signals. Research has been delayed by lack of a direct measurement system. Electromagnetic emanations should be measured over and beyond the presently identified categories associated with electroencephalographs. A device similar to that developed by the Soviet scientists to measure St. Elmo Fire-related emanations from plant and animal life is needed, such as film sensitivities or scope recorders.

PROBLEM HSR-7 Improved Assist Device Expands Self-Sufficiency Potentials for Quadriplegics

A microswitch system is needed which can be activated by a puff of expired air to energize an electronic switch box control for activity. Quadriplegic

(paralyzed in all four limbs) patients and multiple amputee patients have extremely limited capabilities for any self-sufficiency and are almost completely dependent upon assistance from patient care personnel. This presents a tremendous drain on patient care staffs and seriously affects the morale or possible interests of the patient. Any self-sufficiency improvement provides immediate relief in both areas.

PROBLEM GLM-39 Artificial Speech Synthesizer

Communication is becoming a vital tool for the conduct of business and personal affairs in a complex world. The person who has defective, diseased, or injured vocal cords (mute) is unable to speak in the normal manner. He is committed to write his communications or is restricted to so-called talking with those who are skilled in hand-sign language. The problem originator seeks electronic speech means to overcome this. The device should be small enough to be handcarried by an individual. A keyboard of sounds should be provided for intelligible or compressed speech patterns. Operation should be as simple as possible to obviate excessive training for special skills to use it.

PROBLEM BUD-1 Heat and Stress Resistant, High-Strength Plastic for Fabrication of Orthotic Devices

Plastic material permitting ease of shaping to fabricate high-strength orthotic devices that directly conform to an affected hand is needed. Rehabilitation medicine frequently must restore motion and develop capabilities in hands that are deformed or otherwise limited in motion and control. The patients exhibit a wide range of hand sizes, shapes, and anomalies which require individualization in design and function of orthotic devices. High-strength materials are required for the devices. However, steel or other metal proves to be costly and difficult to work.

PROBLEM RRC-9 Automatic Locking Prosthetic Leg

Existing artificial legs have a dove-tail knee joint which holds the limb straight only when weight is applied along the axis of the leg. If the body weight is applied before the leg is fully extended, the joint sometimes fails to lock, resulting in an unannounced collapse which can contribute to injurious falls. There is thus a need for a more positive joint lock with a concurrent device for compliance to allow more normal locomotion.

PROBLEM CHS-14 Magnetic Stimulator for Deaf-Blind Patients

A stimulation device, magnetically coupled for use in deaf-blind patients to increase their environmental awareness is needed. Many patients, deaf-blind from birth, require novel techniques to bring the outside environment to their attention. The problem originator feels that a stimulator magnetically coupled through the skin to circumvent electrical connections can be used in training deaf-blind patients to better handle their environment. The device must be small, lightweight, inexpensive, and operate from 50 Hz to 25 kHz. Since a magnetic pellet is to be used as a transducer, search should include magnetic material properties.

PROBLEM RNV-38 Design and Fabrication Techniques for Making "Between Size" D. C. Motors for Powered Orthotic Devices

Orthotics device design engineers need the in-house capability for building small, d. c., 2000-12000 RPM, between-size motors. The mechanics, i. e., technical details for such fabrication is required. Developers of powered orthotic devices must tailor their designs around standard industrial motors. (Globe Industries Division of TRW, Inc. is a typical manufacturer.) The cost of special, between-size motors from commercial sources is prohibitive. This problem is universal among developers of orthotics devices throughout the world.

PROBLEM TPR-2 Device to Correct Foot Pronation

A technological methodology or device to easily work into an on-line fabrication for supportive corrective of foot pronation is needed. This private practitioner is treating a large number of patients who are experiencing pain and difficulty in walking due to a pronation (inward bending) of the foot at the ankle joint. The patients are immediately relieved by an inner aspect support near the arch of the foot. The support must be provided as quickly as possible and must positively lift the inner aspect without raising the heel, since raising the heel complicates the problem and hinders treatment.

The practitioner sought materials which easily could be worked and shaped to the exact specifications. He is willing to fabricate the device if the materials or means to develop materials are provided. He prefers to custom-fabricate the correction during the visit. He was furnished working samples of the NASA foam-in-place helmet liner resins and was impressed with the characteristics of the foam.

PROBLEM UAM-13 Flexible Oral Transducer Matrix

A flexible transducer matrix that fits against the palate and senses tongue position against the palate during speech is needed. The problem originator desires to form baseline information on tongue position during speech. It will then be possible to use the device in speech therapy by allowing investigators to tell patients to move their tongue forward-backward, etc., to better form consonants and vowels. This would represent a significant advancement in the area of speech therapy.

PROBLEM BMC-4 Improved Arch Support Material

Technology and methodology are needed to quick-set a resin or composite which has high durability and will support as well as flex. The problem originator and his staff are frequently required to construct arch supports for active children. The arch support must provide firm support in its thicker sections and must be able to flex in its thinner sections which are gound to a thickness of about 1/16th of an inch. A commercially available resin identified as C-8, supplied from boating business, has been employed with a limited degree of success. The setting time of 4 hours for the C-8 resin is considered excessive. It lacks strength and durability in its thinner sections. The desired material should be easily worked to avoid technician time for grinding to final specifications.

PROBLEM WLH-3 Elasticity in Long Bones to Determine Optimum Fracture Knitting Condition

Techniques to standardize testing procedures in the determination of modulus of elasticity of long bones are needed. Methods of treatment of long bone fractures are subjective in nature and little is known about optimum tension-compression techniques to provide the most rapid knitting time. If techniques based on the modulus of elasticity can be formulated, clinical physicians would have a valuable tool in the treatment of fracture. Information and techniques should be based stress relations in elastic regions rather than data acquired at stress rupture areas.

PROBLEM WLH-4 Myoelectric Powered Prosthesis

Techniques to sense and condition myoelectric signals for application to appropriate control systems in limb assist devices are needed. Paralyzed patients or amputees could be further rehabilitated if a means of controlling their limbs or prosthesis by normal nervous signals can be generated. While control systems and drive systems are presently being developed, a logical extension of this would be the nerve impulse sensing circuit interface.

PROBLEM TCB-16 New Type of Tracking Cane For The Blind

A lightweight cane which will permit blind persons to "track" on a previously laid out route, such as a path down a corridor upon which coded information has been placed such as right or left turn,is needed. Blind individuals do not have at their disposal an economical cane that can be used by them to "track" a previously laid out course, as a means of getting from one place to another safely. The availability of such a device would be extremely helpful in rehabilitation centers, homes for the blind, etc., where it would be feasible to lay out tracks for the purposes of guiding the blind around the premises. The cane should be economical, lightweight, and capable of translating coded information incorporated into the track into cues understandable to the blind person (such as right or left turn required, hazards, such as stairs present, etc.). An MSFC flash sheet describes a new type of cane for the blind (ATTS-TU MSFC Oct. 9, 1970) which by incorporating the optical sensor from the NASA sight switch can solve the problem quite effectively.

PROBLEM UAM-14 Self-Propelled Experimental Cart

A self-propelled experimental equipment cart capable of travelling from 0-10 mph with 1% accuracy is needed. The problem originator is attempting to determine design constraints and system requirements for the development of a better AK amputee leg prosthesis. His design is contingent upon reducing weight and complexity with a concommitant reduction in body work function. To measure this work function, he desires a cart to travel alongside the amputee which will both control ambulation of the amputee and carry the instrumentation to measure the work function.

PROBLEM UAM-15 Programmer Oxygen Consumption Meter

Circuitry to program the start-stop function on a Beckman O_2 Analyzer is needed. The problem originator desires to control start-stop function on the oxygen analyzer in the work function experiment. Pre-programming relieves the scientist to perform gait analysis during the test. Pre-programming also insures that O_2 analysis does not begin until both the test subject and cart has come up to programmed ambulatory speed.

PROBLEM UAM-16 Cassette Recording and Display of ECG Pulse Rate

A means of recording ECG, output of an O_2 analyzer, and pulse rate and presenting a real time display is needed. To acquire work function of the AK amputees, the above physiological functions must be monitored. The problem originator desires cassette recording if possible. Existing NASA technology can be tailored to provide a solution to this problem.

PROBLEM UAM-17 Respiration Face Mask

A lightweight low profile respiration mask with included J valves to measure O_2 consumption is needed. AK amputees do not function properly when their vision and breathing is restricted or obstructed. Thus, we must have a low profile mask comprised of lightweight material and appropriate J valves to minimize dead space. Dead air space must be less than 50 cc.

PROBLEM UAM-18 AK Prosthesis Fabricated From Composite Materials

Composite materials to fabricate rod prostheses for AK amputees are needed. Problem originator desires to investigate MSFC-derived composite materials for use as lightweight prostheses. Interaction between problem originators and MSFC will be the best and logical solution to the problem. Composite materials show promise for replacing currently used materials for fabricating AK protheses.

PROBLEM UTH-1 A Tactile Projector For Teaching Blind Students

System device and methodology are needed to project classroom chalkboard entries to register on a finger-scanned screen as tactile images. Traditional Braille techniques for reading by blind persons have been questioned by researchers who feel the embossed characters are not the most effective tactile perception codes for reading. New concepts appear to be easier to learn and faster to "read." Blind persons are able to function well in a college classroom, but special problems exist for communicating chalkboard entries in the absence of a new concept projector. The chalkboard scanner should be capable of close-up focus on special sections only. It should be coupled into a system which will relay data for tactile image development on a specially-equipped desk surface provided for blind student finger surveillance. The device should activate electrically-stimulating sensory points or mechanically activated pins which raise above the surface.

PROBLEM SWR-1 Custom Fitted Composite Leg Brace

Technology and methodology to design and fabricate a soft-tissue-conforming long leg brace using composite plastics are needed. The mechanics and operational requirements for a prosthetic device to

support a partially paralyzed leg and thigh or a neuromuscularly weak individual are established knowledge in the field of rehabilitation medicine. The problem of providing a reliable and strong prosthesis with reasonable weight and bulk has been unresolved. The investigator needs materials which also are cosmetically acceptable. Thermosetting plastic composites of the boron-graphite-glass epoxies appear to have the weight/strength/reliability coefficients that are needed if they can be adapted to serve a purpose outside of the original structure use in airframe or space vehicles. There are large numbers of patients who can be provided increased self-sufficiency if an improved brace can be made available at a reasonable cost and worked in ordinary brace and limb shops.

PROBLEM GLM-41 Electrodes to Measure Potentials of the Cochlea and VIII Nerve Action

Highly efficient scalp electrodes to optimally record evoked cortical response potentials from human subjects are needed. The investigator is part of a team which is engaged in a combined clinical and research program with reference to speech and hearing pathologies and remediation. They are seeking to record auditory system receptor potentials and auditory nerve potentials in human subjects without surgical intervention. Data from normal subjects and from subjects having pathologies will be used to correlate pathology with response. Highly sensitive and reliable electrodes are needed since good recording electrodes are essential elements for the study. They will require electrostatic and magnetic field shielding. No other special problems are foreseen. The study will be conducted in a laboratory setting. The technique seeks to provide a clinical tool for diagnosing pathologies of the auditory system. If suitable electrodes are not available, the project must be abandoned.

PROBLEM GLM-42 Automatic Interruptor of Speech to Separate Word by Phonemes During Tape Recording

Technology and methodology to maintain voice qualities of pitch, amplitude and modulation while automatically spacing between phonemes during audiotaping of words are needed. The researchers are providing speech recognition and retraining for patients who suffer from occluded nerve pathways of speech as a result of stroke, accidents, etc., (aphasia). Aphasic patients are not able to recognize values of sound variations unless they are separated by exaggerated time intervals, as compared to what the

normal hearing subject requires for discrimination. Artificial sound separation is needed. The patients need to hear sounds of one syllable words at the natural pitch, amplitude and modulation as close as possible, with interruptions between the phonemes. A great deal of time is required and artificiality is produced if the therapist must audiotape the words by watching a scope and artificially interrupting during phonation. An electronic means is sought which will recognize and separate the words at phonemes so that desired time intervals of 100-200-400-800-1000 milliseconds may be inserted in training of aphasics.

PROBLEM UOF-4 A Method For Determining Blood Coagulation (Clotting) By Phonocardiography

The problem originator is presently studying heart sound which may be indicative of the presence of blood clots in arteries. His work to date suggests that certain low frequency signals, audibly characterized as gurgles, may indicate onset of blood clotting within the arteries. He wishes to evaluate a cardiac microphone for its applicability in detecting blood coagulation.

PROBLEM UOW-1 Improved Switch Control For Use By Totally Paralyzed Cerebral Palsy Patients

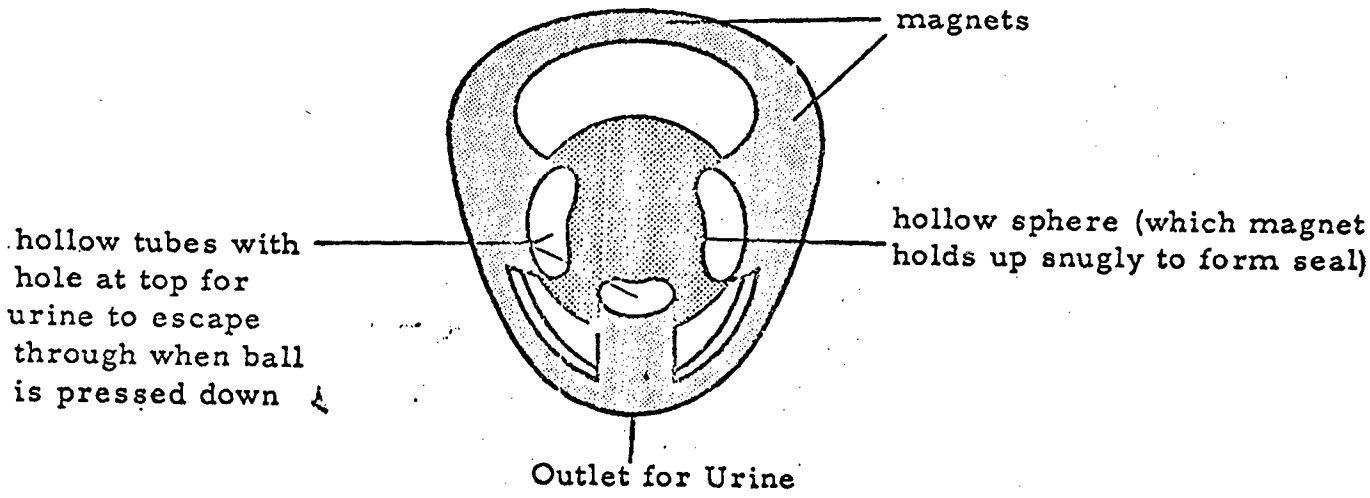
An improved eye switch circuit which does not reuire light shining in the user's eyes continuously is needed. In this country there are a considerable number of children suffering from cerebral palsy, whose sole motor function is limited to being able to move the eyes. The problem originator feels that the NASA developed eye switch can be used to help permit such children to help themselves and perhaps even develop simple vocational skills. However, the light continuously shining in the child's eyes (and associated heat) is considered a major problem. The problem originator desires to use the eye switch or some alternative method but without the concommitant discomfort of heat and light associated with the present eye switch.

PROBLEM UTM-38 Improved Urethral Valve For Nonsurgical Implantation

A biocompatible, urethral valve to control the flow of urine from incontinent patients which can be implanted without surgery is needed. Senile and debilitated patients present special rehabilitation and maintenance problems during medical care and treatment. Many of the patients are unable to control retention and emptying of urine by the bladder. Tonus of the

musculature of the bladder therefore deteriorates and patient morale suffers along with costs of upkeep. Surgically implanted devices such as the one developed earlier at the University of Virginia are not considered to be desirable, due to the trauma associated with the implantation and the considerable bulk involved. With the concept proposed below, the smooth musculature of the urethra will be relaxed (via drugs) and the urethral valve positioned via use of an instrument such as a cystoscope—as opposed to abdominal surgery for implantation.

The device should provide positive control so that the urinary bladder can fill naturally and empty quickly upon demand. It should be biocompatible and implantable without surgical procedures. It should withstand exposure to tissue and body fluids for extended time periods. A magnetically controlled operation (see enclosure) is considered preferable since it is less likely to be accidentally activated than pressure-operated kinds.



UTM-38 Improved Urethral Valve For Nonsurgical Implantation

PROBLEM TCB-17 Acoustic Signal To Alert Blind Persons to Obstacles Between The Waist and Head

Technological methodology and device to provide a warning to mobile blind persons approaching obstacles located between the waist and the top of the head are needed. The laser cane for the blind has the capability to detect obstacles in three areas: (1) between waist and head, (2) between waist and ground, (3) holes or drop-offs in the path of the individual. This device is very expensive and very delicate. The sensitivity to adjustment makes this impractical since normal punishment to the cane alters these adjustments making the device unreliable and this decreases the confidence of the user. A devise is required that would sense only those obstacles between the waist and head, since normal long cane mobility training will enable the user to locate obstacles between waist and ground or drop off in his path. This would make the device less expensive and thereby more widely used by the blind. The device should provide an acoustical signal only when an obstacle is approximately 6 feet from the person and between the waist and head. It may consist of two units: (1) transmitter mounted in eyeglasses and (2) receiver and warning system/battery pack worn at the waist. Reliability and simplicity of operation, along with comfort and appearance, must be taken into consideration.

PROBLEM TCB-18 Permanent Reflective Coating For Use On Canes For The Blind

Technological methodology and material to provide a permanent and scratchless reflective coating for aluminum canes is needed. The present material used in the application of the reflective surface to the cane is a reflective tape. The reflective quality is excellent but is easily scratched and becomes quite unattractive. A material that will protect the tape or replace the existing tape is required. Material must be tough and durable (scratchless). Must either be clear and able to cover existing tape or be a substance that a reflective substance can be added.

PROBLEM TCB-19 Navigation Assistance To Keep Blind On A Set Direction Of Travel

Technological methodology and device to assist the blind to traverse a distance, having no landmarks, in a straight line are needed. Long cane mobility methods are least effective when no landmarks are available (sidewalks, curbs, etc.) such as large open areas (parking lots, fields, etc.). To assist one to cross an area of any size in a straight line will allow the blind a larger degree of freedom of travel. The device should be portable, battery operated and easily set by user. The unit should be as inexpensive as possible. For accuracy a non-magnetic system should be used.

PROBLEM TVA-2 Portable Heart Rate Indicator For Active Patients

A portable, miniature, durable and reliable device to be handcarried by a patient as it monitors heart rate during prescribed physical activity is required. Ward physicians determine the adjusted heart rate for cardiovascular patients (e.g., 60%-70%-100%) undergoing rehabilitation and also state the heart rate to which patients can be safely increased during exercise. Therapists presently are manually recording pulse rates before any exercise is taken, immediately after the exercise, and again after rest periods of 3 and 5 minutes. These data are considered in determining the optimum exercise and progress for the individual patient. However, it is important that the patient be able to monitor his heart rate during such activity, so that he can remain within the levels specified by the physician. Heart rate must be reliably measured and indicated. The device must be durable to avoid down-time. Calibrations are required to indicate heart rates between 50 and 140 beats per minute. Digital, chest or wrist attachment would be acceptable. The device should be small enough to be handcarried during exercise. Rehabilitation planning and patient benefits will be greatly enhanced by provision of accurate and timely heart rate exercise information.

PROBLEM HUV-23 Automatically Operated Magnetic Tape Cassette Recorder

Quadriplegic patients attending college are urgently in need of a control device which would enable them to independently control a cassette recorder for use in the classroom. Conventional cassette recorders require considerable mechanical force and displacement to actuate. Therefore, no simple solution seems readily available for quadriplegic patients who wish to operate a tape recorder but generally do not have sufficient neuromuscular control to do so. A large number of paralyzed patients could become more productive with such modified tape recorders since they cannot write longhand or use a typewriter. A controller of this type should have widespread application to vocational rehabilitation projects, otherwise quadriplegic patients will remain dependent on others for assistance.

PROBLEM NMV-1 Control System To Permit Quadriplegics To Operate Long Playing Recording Devices

A control system actuated by eye movement, breathing, etc., which can be interfaced with a long-playing cassette tape recorder, to permit totally paralyzed quadriplegics a means for taking notes when they are enrolled in educational courses designed to prepare them for greater self-sufficiency is needed. Many of the estimate 100,000 quadriplegics in the

nation can be made self-sufficient to a considerable extent, provided that (1) orthotic aids are developed to assist them move paralyzed limbs and (2) they are afforded an opportunity for specialized education to equip them for a vocation. Significant progress in terms of (1) is being made, particularly in terms of intraoral proportional control mechanisms being developed under NASA-LRC sponsorship. Concurrent progress in (2) is needed. Many quadriplegics are gifted intellectually and can profitably enroll in educational programs. However, being paralyzed they cannot take notes during class as the other students do. They need a very long playing cassette recorder/reproducer which can be operated by whatever residual motion a particular quadriplegic can muster (such as using the breath, eye movement, etc.) to turn on, turn off, rewind, and play back a recorded lesson sequence for study and lesson review purposes. The entire control long-playing cassette recording system should be mountable on a wheelchair, such as the following: Any control mechanism developed should be small, economical, and be adaptable to a variety of inputs, such as eye blink, breathing, muscle contraction, etc., since there is a considerable variation in residual capabilities of totally paralyzed quadriplegics.

The logic circuits developed at Langley Research Center for the multichannel patient assist device can be modified for the purpose at hand. This technology can be interfaced with a single-speed magnetic tape recorder developed for the lunar module instrumentation subsystem (NASA Tn D-6845) which has a maximum recording time of ten hours.

PROBLEM AEB-3 A Light Sensitive Vocational Rehabilitation Aid

A cost-effective, "hands-free" light detector capable of differentiating among levels of light is needed. A device suitable for the totally blind (such as operating a communications switchboard) requires that an individual be capable of differentiating between dark and light surfaces. Small hand-held light probes have been developed by application of aerospace technology. However, they tend to encumber the user who needs his hands free to make connections. Operation of the instrument should require minimal use of the hands. Perhaps a sensing device could be developed which could be mounted on the frame of dark eyeglasses typically worn by the blind.

PROBLEM AEB-2 Measurement of Physiologic Stress Parameters

Blind trainees sometime find exposure to new situations and tasks to be very stressful. Presently, it is difficult for the instructor to evaluate degree of stress to which the trainee is being exposed. Obtaining an

objective measure of much stress is important both in terms of (1) prediction of success once the trainee has been placed vocationally and (2) in adjusting the training program so as to make it minimally stressful and descriptive. A wireless method is needed to prevent undue encumbrance. Signals will be recorded on a strip chart recorder and may also be fed into a small computer for analysis.

PROBLEM AEB-1 Method For Identifying Denominations Of Paper Money

A significant number of the totally blind could be employed as cashiers in small vending operations if they had some reliable means of differentiating among the various denominations of paper money, thus permitting them to (1) insure they were not being cheated by someone giving them a one dollar bill and claiming it was a five dollar bill and (2) insure that they could, on their own, make proper change which invoked paper money. A cost-effective, portable device is needed which will permit the totally blind to differentiate between $1, $5, $10, and $20 bills. The apparatus should be appropriate for counter-top use and must be relatively inexpensive. It will not be required to differentiate between genuine money and substitutes.

PROBLEM RNV-37 Surgically Implanted Peroneal Nerve Stimulator

Researchers wish to investigate the extent to which long-term electrical stimulation will promote restoration of peripheral nerves, with a view of rehabilitating individuals suffering from partial or complete paralysis due to atrophy associated with illness or injury. A surgically implantable pulse circuit complete with batteries and electrodes and magnetic switch for external control is needed.

PROBLEM OCH-7 Work Space Analyzer For Upper Extremity Amputee

The problem originator is attempting to evaluate the work situation potentials for a variety of patients at a medium size convalescent hospital. These patients vary in age from infants to 20 years old. Some of the patients will be convalescing from injuries and some from illnesses requiring long term therapy. When an individual has been fitted with a prosthesis to substitute for an upper extremity, work space limitations are encountered which must be realistically evaluated for work puposes. The device and method must be applicable to young children as well as young adults. Both must be safe for use with human patients. Both should quantitatively measure the extent of useful motion with a prosthesis and define the space movement limitations.

PROBLEM HUV-22 Automobile Driving Assist For Triplegic

Triplegics have the use of one of their hands and are employable within constraints of their limitations. They require motivation to seek employment and to gain more independence. This could be enhanced if they were able to operate their own automobile. Presently they are completely dependent upon someone else for transportation requirements. The problem originator believes NASA-developed controls could apply here. The element could be hydro-electric and therefore easily interface with power brakes, transmission, and steering assemblies through a torque-boost mechanism. The single-handed operation of the unit should provide the capabilities to stop, move forward, turn right and left, reverse, operate turn signals, dimmer, and horn, as well as turn on and off headlights.

PROBLEM TCB-2 Blind Person Guidance Detector of Impregnated Paint Or Wire Boundary Marker

Technological methodology is needed to detect impregnated particles in paint or wire boundary markers system to guide blind persons. Mobility is one of the greatest problem of blind persons. A particle detector carried by a blind person could emit an audible tone or vibrate to indicate "safe direction" or "off-the-path", if detector-sensitive particles were impregnated into a paint or wire and that paint were applied to indicate safe indoor passage areas and the wire were embedded to indicate safe outdoor passage areas. This effectively eliminates the need for a cane.

PROBLEM TCB-4 Non-Magnetic Homing Device For Use By Blind Persons

Technological methodology is needed which will provide positive homing directions when used by blind persons. Congenitally blind persons have considerably different concepts than those formed by a sighted person who lost vision after visual images had been formed and, therefore, are able to retain those images for reference in learning or relearning. This presents a very real problem in the kinesthetics of mobility orientation as it affects directions, obstacles, time, and distances. Rehabilitation and ongoing needs exist for the blind. This device should be non-magnetic since the present magnetic-type Braille compass appears relatively useless in a city or in a vehicle because of interferences from metallic components, and the device contains warning instructions against such use.

PROBLEM TCB-6 Urine Glucose Teststrip Provides Tactile Readings

Management of diabetes usually requires a frequent evaluation of the amount of any glucose which may be present in urine. Test tablets and teststrips

have been developed to permit individuals to quantitatively evaluate this situation without a visit to the physician or laboratory. Blind diabetics must manage medicine and diet based upon this same set of criteria and need a means to "read" the test. A teststrip is needed which will dissolve in length proportionate to the amount of urine glucose exposure so that it can be "measured" against a readout on the container or else one which will expose verticle/horizontal/diagonal "ridges" for tactile quantitative readouts.

PROBLEM TCD-1 Portable Sound Meter For Use By Deaf

A portable meter for measuring acoustic levels (ambient) of the environment and amplitude of voice output for deaf persons is needed. Deaf persons encounter unusual difficulties in learning to speak and, thereafter when speaking, because they cannot realistically gauge the amplitude or qualities of the acoustics. They have no way to estimate the noise level in any surroundings. They can only estimate the acceptable level of their own speech amplitude by observing the reactions of persons in their vicinity. The device should be as simple and easy to operate as the light meter devices used for photography. The operation should be from acoustic levels rather than optical levels. The cost factor should be kept in mind since quantities probably will be required.

PROBLEM OCH-1 Lightweight Long Leg Braces For Children

A variety of accidents, illnesses, and birth defects are causing an increasing number of children to require the use of long leg brace support during rehabilitation care and treatment. The present long leg braces are constructed of metal. Such braces prove to be too heavy and unmanageable for the children to the extent that rehabilitation is delayed by a significant factor. Lightweight, sturdy, adjustable long leg brace materials to replace the metal braces seem to be a reasonable answer. It is believed that plastic materials should have been developed having strength and reliability characteristics of metal and at a fraction of the weight.

PROBLEM OCH-5 Failure-Resistant Cerebrospinal Fluid Shunt

Unvented cerebrospinal fluid builds up pressure in the skulls of children suffering from hydrocephaly (water on the brain) and causes dangerous enlargement of the skull together with a very bleak prognosis. One method for medically treating this kind of patient is to provide a shunt between the ventricles of the brain and a vein of the circulatory system. This technique has had mediocre success since imperfections or seams in the shunt appear to eventuate clotting and to attract obstructions which impede normal fluid flow. Presently, if the original shunt fails, it is usually surgically replaced. After two shunt failures, little can be done to alleviate

the conditions and the hydrocephalic child rapidly deteriorates to mere vegetating. What is needed is simply a biocompatible, seamless shunt to perform the same function under similar conditions.

PROBLEM OCH-6 Sensory Hemiplegic Stimulator

Certain individuals who become paralyzed on one side only (hemiplegia) suffer only sensory paralysis and they are still able to exercise control over motor activities. These individuals soon tend to avoid using the affected side because of a lack of sensory input from touching, moving, etc. Muscles of the affected side then tend to atrophy (waste away) from lack of use and the person's ability to function suffers. A system is needed that will provide a tone or other stimulus to remind the hemiplegic to use his paralyzed limbs. It appears unlikely that the sensory pathways can be used in this connection since the hemiplegia is directly related to those pathways' failure to function. Anything which reinforces the hemiplegiac's utilization of his affected side will contribute to his well-being and rehabilitation.

PROBLEM TCD-2 Warning System For Use By Deaf

A visual or vibratory technology which can be remotely activated to alert deaf persons for vital communications is needed. Many deaf persons have lost their lives in hotel or apartment fires because they could not be alerted and warned in the normal manner which is oriented toward auditory stimuli (bells, sirens, door knocks, etc.). This is particularly significant when the persons are residing in hotels, motels, or apartments where access to living areas is guarded by internal and external locking devices.

PROBLEM TCD-3 Portable Substitute For Door/Telephone Bell For Deaf

A relatively inexpensive, portable, remotely controlled device to be carried on the person to alert them of door/telephone communications is needed. Inestimable losses and inconveniences have been incurred by deaf persons because they were unable to hear a knock at the door or the ringing of a telephone bell when there was an important need to communicate. Others who live in the vicinity of deaf persons also have been seriously inconvenienced as a result of loud and repeated door knockings which have been made on the chance the vibrations could be felt and the appropriate response made. Something similar to the wrist watch alarm could be considered. The differences in vibratory repetitions could signal the difference between a door bell ring and telephone ring. The portable control device should be door-frame mounted and be wireless.

PROBLEM TCD-4 Noise-Activated Flasher Warning For Deaf Driver

A growing number of automobile accidents occur because individuals fail to hear the sounding of a horn or the siren of an emergency vehicle. It is particularly significant for deaf drivers because they are unable to hear the warning sounds at all. A small dash or windshield-mounted light flasher activated by usual and unusual auditory driver sounds (horn, siren, etc.) would alleviate this situation by alerting the deaf driver visually in such instances. The device should be small to avoid blocking the driver's view and large enough to be seen. Dash mounting or windshield mounting is suggested since they are convenient reference points under usual surveilance by drivers. Sound source could be differentiated by the visual pulse differences.

PROBLEM TCD-5 Speech Analyzer

Persons with speech anomalies frequently do not hear the differences between normal speech and their own. This is particularly true of the deaf, regardless of the degree of hearing loss. A means is needed which will display the speech patterns for comparative viewing. A scope display is considered as one of the means of visually presenting speech patterns, and possibly a combination of clustered waveforms with colors to represent tone qualities as well as loudness and inflection factors of speech. The methodology or device should possibly have the capabilities of retaining the acceptable speech pattern for superimposing the learner's patterns to permit comparisons anda goal for achievement.

PROBLEM UTM-30 Biocompatible Bone Interface for Prostheses

Biocompatible attachment of prostheses has been a problem which has been resolved short of its solution for a number of reasons. Advances have been made in most areas with constant refinement of the prostheses and techniques. Recent attempts have been made by powdering and compacting magnesium before firing it to produce a porous material for bone interface of prosthesis. The problems encountered with materials used thus far have mainly been concerned with lack of elasticity and fracture tendencies. Hence, a need still exists for a material that has sufficient elasticity to resist shearing forces without fracturing in order to be able to biocompatibly interface living bone tissue and a prosthesis at a weight-bearing joint.

PROBLEM UTM-31 Plastic Prosthetic Materials

The problem originator and his staff need suitable plastic materials for use as prosthetic devices on nonweight-bearing joints. They have used silastic and determined that it has excellent wear characteristics; however, difficulty in molding or shaping greatly adds to its cost-in-use and it is considered to

be excessively expensive. Materials are needed that possess the resiliency and durability (wear) characteristics as present in the silastic plastic and yet are of such a nature that they can be readily cut, shaped, or worked into prosthetic devices as required. Research is oriented toward preventive medicine in design and use of the prosthetics. The investigator presently is working with applications for use with animals and will transfer the technology to human use if feasible.

PROBLEM UTM-32 Improved Design For Foot Supports

The normal foot is constructed to provide three points (tripod), one at the heel and one each at the base of the large toe and at the base of the small toe, for weight support in standing or walking. People who suffer from rheumatoid arthritis, leprosy, and diabetes present difficult pressure problems for the feet because they cannot feel the pressure-caused damage. Poor circulation of diabetics makes them prone to ulceration from pressure. A material that is easily worked or shaped is envisioned as a means of providing prosthetic support for these patients. The material must be resilient so that it cushions the weight and should allow for air passage to avoid problems of odor and mycotic infections. Cost is a serious problem to such patients due to the long term nature of their illness and to other patient care implications.

PROBLEM UTM-33 Form-Fitted Foot Pad Brace

There is a critical need for custom-made supportive materials. The problem originator has been searching for a foot pad brace which is form-fitted, porous, durable, absorbs pressure of friction forces, and is easily worked directly on the foot. Both silastic and closed-cell neoprene have been rejected because of lack of workability and excessive expense. On-line fabrication of the supportive devices is considered to be an advantage in costing, provided the resiliency and other nature of the support is retained.

PROBLEM UTM-34 Lining Absorbs Pressure and Friction Forces

Some patients suffering from arthritis and other patients with back pain that can be relieved by supportive bracing are fitted with a hard plastic device called a Laminated Taylor Splint. This splint extends over a considerable length of the back and extensively contacts skin tissue. Pressure forces are inherently a part of the support provisions of the splint and friction forces developed from breathing or body movements. A lining material that will absorb the forces derived from skin contact of the splint is needed. In addition to the cushioning and resiliency features of the lining, it should also be sufficiently porous to allow for air passage to avoid sweat and odor buildup.

PROBLEM UTM-35 Lightweight Long Leg Braces

Rheumatoid arthritis patients frequently have collateral ligament injury or loss in the knee. This situation also is treated in other patients who develop this problem from a variety of accidents. The current best method for treating the condition is to avoid surgery if possible. Long leg braces are prescribed in conjunction with a molded pretibial shell which grabs and holds the joint avoiding strain on the ligaments. A lightweight replacement is needed for the heavy metal long leg braces. These present braces are too heavy and bulky for women or children to use. They are excessively expensive and are non-physiologic in medical function for the patients. It has been suggested that a form of plastic which diffuses the pressures throughout thigh and leg soft tissues be used to fabricate the braces.

PROBLEM RNV-32 Measurement of Energy Expended in Walking

This investigator is developing an improved means of diagnosing disorders of gait and evaluating "quality of walking." Gait patterns can be analyzed, appropriate diagnoses made, and corrective surgery or improved bracing techniques can be implemented through information gained from the computer, if proper data acquisition and analysis of human motion patterns are available. The researcher has taken the first steps toward realization of "on-line", computerized evaluation and diagnosis of orthopedic cases and problems. Gait motion studies have been made for patients with various gait disorders. Motion patterns of a normal subject also will be studied. A method for measuring the energy expended by a patient as he walks a certain distance is needed.

PROBLEM GLM-43 Quick Attachment/Release Clamp

Patients brought to the rehabilitation clinic in wheelchairs or on stretchers frequently have ongoing intravenous infusions, urinary bladder catheterization and collection, traction devices or splints that need support. During transportation these need attachment to the vehicle. When the vehicle is used for other patients, it is desirable not to have the protrusions that are required for support of these attachments. Therefore, a quick attachment/release clamp is needed that is usable to clamp a rod, for example, to a tubular portion of the vehicle. The clamp used at present has four thumb screws. This device is needed for security but is unnecessarily cumbersome and time consuming.

If the design permits, it is desirable to be able to immerse the clamp when attached to a stretcher placed into a hydrotherapy bath.

PROBLEM GLM-44 Quickly Adjustable Crutch

Many patients seen in the rehabilitation clinic need fitting to a crutch at their first visit so that a pair may be set aside for their repeated use. However, often these patients are so debilitated due to weakness or due to discomfort from burns that it is of interest to adjust the crutch easily while the patient remains upright and with minimal movement while attended by the one therapist. Two adjustments are required: the hand hold and the total length. Either wooden or metal crutches may be used. The requirement of absolute security appears to rule out twist-lock devices for the length adjustment; a self-locking mechanism such as is used on laboratory stools might be usable only if modified so as not to extend when the crutch is lifted. But what about the hand hold? This mechanism might also be used to improve adjustment of walkers used in the rehabilitation clinic. These use push button detents on each of the four legs. They cannot be readily adjusted while the patient is supported by the walker. Some sort of visual indication is needed for evidence that the adjustment is not altered. Sufficient strength is needed for patients up to about 450 lbs.

PROBLEM GLM-45 Material For Water Stretcher

Burned patients in the rehabilitation clinic are transported to the hydrotherapy bath on a stretcher that may be immersed in the bath. Because of open wounds, tissue grafts and potential pain, a slick, smooth material is desired which may be attached to the standard frame. The material should be without holes; that is, a sieve or net is not usable as movement against the patient will cause damage. A porous membrane might facilitate drying but might more readily harbor bacteria. Ready sterilization is, of course, required. Attachment to the stretcher frame in the past has been by a rope passing through eyelets in the rubberized cloth material. All these items are too rough. Possibly a teflon-like sheet which can be welded around, or strapped to, the frame would fill the need. The material and straps need to support 450 lb. patients on occasion. It would be most desirable to have a material which can permit the patient to spend 24 hours a day on it without discomfort and which is strapped to a frame when needed for transportation of the patient.

PROBLEM GLM-46 Adjustable Cradle For Covering Burned Patients

Burned patients are highly susceptible to infection through the skin. During transportation to the rehabilitation clinic they are moved on a stretcher. They are covered by a sheet which, however, is not in contact with them but is supported by a cradle. This cradle may consist of three semicircular hoops which are attached to two horizontal members in a flexible manner for easy collapse and storage. Present cradles are not adjustable to permit burned patients with traction devices, splints, or just bulky patients, to conveniently fit. An adjustable cradle is, therefore, needed. It is important that the cradle not slip during transport of the patient. For this reason, the present device has been suggested to be modified so that the two horizontal straps be made L-shaped so as to catch on the edge of the trough for the mattress. However, there is still the need for adjustment of the volume enclosed by the cradle to suit large patients, traction devices, or elevated splinted limbs, etc., as is often the case. Burned limbs that hang over are at present swathed in towels soaked with sterile solution, a poorly acceptable compromise.

PROBLEM GLM-47 Improved Stretcher Design

Patients are transported to the rehabilitation clinic on standard stretchers which apparently do not meet many modern needs. Antique methods have not been revised. Some patients are larger than the stretcher will safely permit. Stretchers need to fit through standard hospital doorways and certain attachments are at times necessary. Permanent projections are bothersome and dangerous when not needed. A number of adaptations are desired.

1. An adjustable cradle (see GLM-46)

2. Adjustable supports for intravenous infusion bottles at head and foot (see GLM-43 for quick attachment/release adjustment clamp).

3. Lateral, adjustable shelf for big patients (up to 450 lbs) or for limbs on supporting splints.

4. Traction suspension devices for all four extremities, at whatever angle is needed. If traction includes weights, there should be a way to keep the weight from swinging during transit.

5. A rack for portable oxygen cylinder.

6. A heater for the patient who is burned, has no clothing, and is covered only by the sheet over the cradle.

7. A readily attachable and detachable (probably by use of a frame) water stretcher. (See GLM-45 for material; Institutional Industries, Inc., Cincinnati, Ohio 45238 "Surgilift" uses multiple straps to attach stretcher material to frame and turn-jack device for elevation or lowering of patient; material is too coarse for patients who have burns.)

PROBLEM GLM-48 Ceiling Attachments In Hydrotherapy Room

Rehabilitation patients in the hydrotherapy room need easier handling by single therapy personnel. Fixed attachments to the therapy tank or electric wires on the floor are undesirable and interfere with patient handling. Suitable flexible, adjustable ceiling attachments are needed for (a) infra-red heat lamp and (b) intravenous solution bottles.

An infra-red heat lamp needs to be positioned where it will keep the patient warm after the therapy bath. It needs to be adjustable essentially in all directions for adjustment of intensity and direction.

Patients may have intravenous solutions administered via arms or legs while in the tank. It is necessary to allow short personnel to attach the bottles to a hanger and to raise or lower the bottle with the patient as he is lifted, then lowered into the hydrotherapy tank by means of a hoist. It is important that the end design permit one therapist to handle both patient and his intravenous bottle conveniently. Interfering may be the presence of splints and traction devices. These may be supported by clamping to the patient stretcher.

PROBLEM GLM-49 Monorail Patient Transport System

The user institution is designing a burn ward which will have 17 beds. These patients each need to be moved to a nearby hydrotherapy tank with a minimum of trauma. Thus, it is desired to obtain a system whereby a patient is readily translocated from bed to tank without repositioning such as by moving him to and from a stretcher. Slings are not acceptable since the patient-supporting material needs to be more rigid.

The patient will be in bed on the same support as that which will transport him and then support him in the hydrotherapy tank and return. Existing mechanical hoists for patients are not practical for these patients since they are designed to use supporting slings and they interfere with ready access to the patient as when in the tank.

Some patients will have intravenous tubing, traction, splints, urinary catheters, etc., which must be moved with the patient. Some patients will

require restraint, however. Safety and ease of operation by one attendant alone is important. All beds need to be served. The desired monorail system may use a hoist like the one used in the clinic at present: This hoist moves several feet laterally, upon an I beam by manual movement of the stretcher it supports. The stretcher is raised and lowered by an electrically driven chain hoist.

PROBLEM GLM-50 Catheter Support For Rehabilitation Patients

At the University of Texas Medical Branch, rehabilitation patients in the hydrotherapy tank may have a catheter in their urinary bladder. Normally the collecting bag is kept outside the tank. Movement of the catheter tubing is undesirable. The weight of the filled tubing tends to pull on the catheter. A support method is needed to keep the weight of the tubing from moving the catheter.

ARTIFICIAL ORGANS AND ORGAN ASSIST DEVICES

PROBLEM BLM-13 Nonthrombogenic Material For Use As A Blood Interface

Nonthrombogenic biomedical material suitable as a blood interface is needed by the problem originator. This material must be noncarcinogenic to be suitable for processing into various configurations for surgical implantation. A form of carbon developed by a considerable aerospace research effort was considered to be a possibility for these unique medical requirements.

PROBLEM UTM-1 Physiologic Data Handling—Systems Approach

The problem originator is establishing a data acquisition and reduction center in an artificial heart test and evaluation facility. The facility will acquire large amounts of data from varied sources. The artificial heart

or heart-assist device will be tested for its electrical and mechanical properties. It will be subjected to environmental tests, evaluated in mock circulations, physiologically evaluated in animals, and finally implanted in humans. The physiological parameters will be monitored during surgery and 24-hour monitoring will continue for many weeks while the animal's condition is being evaluated. The human patients necessarily will have to be monitored later. Some of the in vitro tests must be continuously monitored over long time periods for failure analyses. Automatic control of electrical and mechanical tests are included in planning. Guidance technology is needed concerning interfacing a large number of analog variables to the computer. Continuous monitoring of physiological parameters, methods of real time data reduction, file structure of data storage, methods of retrieval, automatic control of failure tests, and automatic determining when a failure either has occurred or may occur are all facets of this same problem.

PROBLEM CHS-11 Artificial Eye Lens

A large number of children suffer from a condition of cataracts on their lenses. The lenses are surigcally removed to prevent blindness. Glasses with eyeframes and contact lenses have not proven to be effective with very young children, and a modified means of replacing the lens with a semi-permanent functional lens is needed during the rather critical formative years when much about the self and relationship of self to the environment is acquired. Technological methodology and device to operate as a lens for the human eye after surgery for cataracts in eyes of children are needed.

PROBLEM UTM-24 Artificial Kidney Support Matrix

The investigator is conducting research for the development of artificial organs. He has experimented with several support matrix concepts to separate the flushing solutions from the cellophane tubing which transports blood in an artificial kidney device. He has been able to improve the support concept by using a matrix of points provided from a photo-etched mold. He needs to be able to obtain points at least 3/100-inch to have an effective flushing flow opposite the blood. There should be about 600 points per square inch on the plate to be photo-etched. The depth of photo-etching should provide a mold for a point average of at least 3/100-inch in length. Photo-etching is considered the best uniformity potential process.

PROBLEM UTM-25 Ionizing Radiation Detection of Thrombogenesis

An implantable monitor is needed to detect low level beta radiation from build-up of labeled blood components in thrombogenic response to interfacing. The investigator is conducting research with animals in the development of artificial organs (artificial heart, artificial kidney, etc.) for implantation within the body. Various materials are being tested for their biocompatibility

as an interface with blood and other body fluids or tissues. Blood tends to clot if the interface is not fully compatible. Thrombogenesis (blood clot formation) must be monitored as a critical evaluation. A means is needed to detect the early stages of thrombogenesis.

PROBLEM UTM-27 Miniature Mosaic TV Camera

The investigator is conducting experiments for development of an artificial eye. He plans to receive and transmit visual images from a television camera implanted within the human eyeball. Output from the TV camera will be fed into a computer system which will translate it into signals that can be relayed to the brain. The design of the system has been formulated and is considered functionally acceptable. He needs a camera capable of transmitting high speed mosaic pictures. It must be extremely miniature to be implantable within a human eyeball. A mosaic type of camera which is an array of photo cells suits this purpose better than the conventional line transfer of data. It must be safe for use within the human body.

PROBLEM CHS-12 Dipole System Auditory Multichannel Stimulation of the Brain

Technological methodology and devices are needed for subminiature dipoles to be surgically implanted in an auditory brain area (e.g., cochlear nucleus). Auditory information needs to be supplied to a deaf child during the critical growing years or certain brain functions central to speech and language function may fail to develop. Dipoles stimulation is the logical choice when researchers are ready to move into practical applications of stimulation since dipoles overcome the crucial problem and remain permanently positioned, unaffected by growth in brain tissue.

Dipoles should be about 0.5-4.0 mm in length, 0.5-1.0 mm cylindrical diameter, function as a receiving antenna while remaining biologically inert, contain internal detector and filter circuit to convert pulses of radio energy into pulses of dc current (output currents of 100μ A may be required but smaller currents (10-20μ A) may be acceptable). Extensive animal testing is contemplated, if the idea proves technically feasible, before it can be suitably considered for humans.

PROBLEM SWC-13 ECG Data Compression Techniques

A system for reading 1/4-inch tapes, digitizing information, and recording compressed information back onto tape is needed.

PROBLEM TCD-9 Portable Amplifier System For Patient With Partially Inactivated Vocal Cords

A battery-operated throat microphone and amplifier system which will provide voice communications in a room without PA system is needed. Counselors

for vocational rehabilitation of the deaf and the hard of hearing are often concerned with concomitant problems related to speech and speech quality in communications. The conditions frequently are aggravated by or caused by illness or infections. Mumps infections can leave conditions wherein the vocal cords are partially inactive. In such instances there exists inability to speak above soft output. The needed system should be portable and operate directly from throat contact to avoid the necessity of pickup of weak signals over any distance. The amplification should be sufficient to permit speaking to groups of people in room situations where a public address system is unavailable.

PROBLEM SNM-25 Development Of An In Vivo Blood Glucose, pH and pO_2 Analyzer

Development of an in vivo blood glucose, pH and pO_2 analyzer and supporting telemetry is needed. Adequate long term of cardiopulmonary assist devices and permanently implanted artificial heart require that the effects of such devices upon blood constituents be evaluated, in addition to performance of the devices themselves. The device desired for this purpose also has implications for other areas, as for example, in the management of diabetes which usually requires a frequent determination of the amount of the blood glucose. The device developed must be suitable for use in vivo, implantable and be reasonably light in weight. The associated telemetry systems must be portable and easy to handle. The power source life should be greater than 2 years or else should be rechargeable without removal from the body.

PROBLEM BLM-27 Device to Telemeter EKG Data From Convalescing Heart Transplant Patients

Researchers at Baylor University College of Medicine requested assistance in developing a small, noninvasive, nonencumbering telemetry system suitable for telemetering EKG signals from convalescing patients who have undergone cardiac transplants. Excellent instrumentation for monitoring the transplant patients during the post-operative phase is available in the hospital's coronary care unit. However, it is essential that the patient be followed during the convalescent phase, in locations remote from the monitoring equipment which is available in the hospital's coronary care unit. To monitor stress conditions and onset of rejection, the researchers needed a small, wrist-watch type EKG telemetry system which could be worn by the convalescing heart transplant patient as he went about carefully controlled activity sequences. The system could also be used to advantage with other than transplant patients to monitor cardiac function.

MENTAL HEALTH

PROBLEM PVA-4 EEG Electrode Holders

The researcher needs a convenient method for holding and repositioning EEG electrodes in performing various clinical experiments.

PROBLEM SNM-24 Brain Resistance and Impedance Changes Under Anesthesia

Problem originator has identified EEG signal variations among patients undergoing surgery. He feels impedance changes in the brain caused by trauma or shock may be correlated and desires assistance in acquiring additional technology on EEG measurements versus tissue impedance.

PROBLEM TPR-1 Electro-Sleep Electrodes

Suitable electrode methodology and device for compatible use with an electro-sleep excitation device are required. The problem originator is providing therapy to certain of his patients with an Electrosone-50 Sleep Machine. He has found that commercially available electrodes which are designed for use with the machine are not fully satisfactory. Problems have been encountered where the leads separate or slip out from the gauze-like electrodes that are shaped like small (1/2 x 1 x 2-inch) pillows. Four electrodes are in place simultaneously for the therapy—one in place above each eye and one of each mastoid area. Electronics should provide constant, good electrical contact when set in place. A relatively large surface electrode is required to stimulate the prescribed area as indicated from documented experience in this sphere of interest.

DETECTION AND TREATMENT OF HEART DISEASE

PROBLEM NMA-3 ECG Cable Take-Ups For A Portable ECG Monitor In An Intensive Care Unit

Small ECG take-up reels are needed for a portable ECG monitor. The monitor is maintained in the intensive care unit and is used in surgery or the emergency room as required. The 4-foot cables frequently become entangled and critical time is lost in attaching the patient to the machine. Time consumed in releasing the cables can be important to the treatment of a patient during emergencies.

PROBLEM UAM-1 Capacitive ECG Electrodes

The problem originator monitors ECG and heart sounds with the same transducer during continuing research on heart disease detection and treatment. Reduced numbers of electrodes save time during attachment and reattachment for the data acquired. He requires capacitive electrodes to simultaneously measure ECG and heart sounds and reduce possibilities of shocking the patient, since no current flows in the body with capacitive electrodes.

PROBLEM UAM-2 Heart Sounds Telemetry

The heart sounds of convalescing cardiovascular surgery patients are monitored during mild exercise. Hard wire instrumentation is presently being used. The problem originator seeks to remove the interroom cabling and to be able to telemeter directly to the monitoring station. He, therefore, requires a heart sound telemetry unit to transfer signals from the exercise room to a monitor station.

The team provided the problem originator with a complete list of all "state-of-the-art" physiological telemetry. A NASA-developed phonocardiogram system incorporating a chest microphone will also be sent for evaluation to the researcher. The existing telemetry package with its microphone should solve this problem.

PROBLEM BVA-1 X-Ray Transparent Electrodes and Leads

The problem originator wants to monitor extensive ECG information while obtaining x-ray, dye-study information on the cardiac circulatory system. ECG leads and electrodes presently negate dye-study effectiveness because they mask the arteries and veins. Interference of the smallest of wires can be misleading since the prime interest lies in the circulation of small veins and arterioles. The researcher requires essentially x-ray transparent ECG leads and electrodes.

Several interesting approaches to this problem were retrieved from a NASA Data Bank search. Tech Brief 68-10363 contained additional information about an electrically conductive film which is transparent to radiation. This material hopefully may be fabricated into suitable x-ray transparent electrodes.

PROBLEM RRC-1 High-Energy Cost Exerciser With Ergometric Monitor

A portable, low-cost, high-energy cost exerciser technological methodology and device and the means to measure expended energy are needed. Patients convalescing from cardiac illness or certain other disabilities frequently require high-energy cost exercise in their rehabilitation programs. The physiatrist therefore prescribes measurable degrees of exercise. The patient may be overstimulated and overmotivated if he participates in team or group activities, or understimulated and undermotivated if he is unattended during exercise at home. Both fail to attain the desired goal. The device should be sufficiently small to be portable. It should be interesting and safe for use by a cardiac patient and should provide high-energy cost conditioning and accurately (±5 percent) measure expended energy.

PROBLEM RRC-2 A Method For Accurate Cardiac Telemetry From Active Subjects

Computer analysis of clinical ECG waveforms has yielded information on "S-T depressions" which have been interpreted to be an indication of cardiovascular malfunction. The problem originator considers this information to be significant in relation to patients' reactions during participation in cardiac rehabilitation exercise programs. He seeks a means to monitor both heart rate and ECG waveforms of exercising patients. Both hard wire and wireless telemetry are eligible for consideration. The patient should be minimally encumbered and the equipment must be safe for use with cardiac patients. There should be a direct and accurate readout of the ECG waveform to indicate any possible S-T depression. A variety of commercially available ECG telemetry devices have been considered, but fail to provide the required waveform precision.

PROBLEM UAM-12 Cardiovascular Dynamics Models

The investigator employs a cardiovascular model consisting of a 30-meter length of penrose surgical tubing at rest on a porous aluminum extrusion and connected to a 30-meter slotted box. A blower attached to the slotted

box should distribute pressure to uniformly lift the tubing from the extension. However, the pressure proves to be insufficient to raise the tubing except for the end distal to the blower, causing unstable vertical and horizontal plane oscillations. The poor pressure profile must be corrected to continue research. A means to provide a constant pressure profile in the end box of an elastic artery model which rides on an air bearing is needed. Any proposed methodology should recognize that static pressure rises monotonically with distance away from the blower, due to conversion of velocity head to pressure head along the length of the box in the present configuration.

PROBLEM AVA-2 Carotid Artery Pressure Waveform Measurement

The investigator has been using a glycerine-filled transducer to monitor the pressure waveform of the carotid artery in his patients. He uses the acquired data to check circulation and correlate these findings with normal sphygmomanometer blood pressure readings taken from the arm. The glycerine-filled transducer is no longer being manufactured and a suitable substitute is needed. A flexible pressure transducer to measure carotid artery pressure noninvasively in humans is needed. Flexible electrode technology developed at Ames Research Center may be applicable to this problem.

PROBLEM PVA-6 Bandpass Filtering For EEG Alpha Rhythm Signals

A bandpass filter to attenuate signals outside of the electroencephalogram (EEG) alpha rhythm signal band (8-13 Hz) is needed. Methods to teach cardiac patients to completely relax without employing pharmacological agents are being investigated to provide an improved clinical regime for a large number of patients who can benefit from the self-help. As a psychiatrist coaches each subject, he monitors progress in relaxation with EEGs. A generation of high intensity alpha rhythm relative to other rhythms is a criterion indicator of successful relaxation by this method. The bandpass filter is intended to reflect variations in the intensity of the EEG alpha rhythm signals directly into a system which will correspondingly vary the intensity of a display lamp. The equipment will be used in the physiology laboratory, in the clinic, and in hospital rooms as required.

PROBLEM NUM-1 Methods For Interpreting Ultrasonic Doppler Blood Flow Velocity Signals

A method of signal processing and interpretation so that accurate blood flow velocity information can be reliably gleaned from ultrasonic Doppler blood flow velocity signals is required. The problem originators have used spectral analysis and zero crossing techniques and a Sonogram

analyzer for processing blood flow velocity signals obtained by ultrasonic Doppler blood flow velocity apparatus. An accurate approach that will account for turbulent flow and unusual vessel internal geometry (such as placques) is needed.

PROBLEM NUM-2 Measure Diameter of Femoral Artery by Ultrasonic Pulse-Echo Method

Equipment and techniques for measuring blood vessel diameter non-invasively are needed. The problem originator wishes to use ultrasonic pulse-echo techniques to measure the diameter of the femoral artery. Previous attempts have been unsuccessful because of near-target blindness, poor resolution and loss of target. Ultrasonic pulse-echo technology, particularly for near-targets with high resolution is needed.

DETECTION AND TREATMENT OF CANCER

PROBLEM UFM-6 Xeroradiography of the Mammary Glands for Detection and Multiphasic Health Screening

Xeroradiographic mass screening tests for detecting breast cancer are being considered to reduce medical treatment costs and increase effectiveness of the screening process. A method is needed to rapidly xeroradiograph mammary glands. Mass screening of other soft tissues will follow if suitable and successful procedures are developed here.

PROBLEM LVA-3 Radioactive Microcell Counting Techniques For Diagnosis and Treatment of Leukemic Disorders

It is extremely time consuming to use microradiography to detect the amount of tritiated thymidine uptake by rapidly growing malignant leukemic bone marrow cells. It requires 7 to 14 days to expose the emulsion to H^3 beta particles and another 12 to 14 hours to microscopically count the exposed grains in developed radiographic emulsions. The procedure is a gross representation of radioactive uptake since the stem cell, monocyte, or megakaryocyte types cannot be identified. Identification of these cell types is a prerequisite to specific treatment of leukemic patients. The researcher needs a microdetector for beta particles (H^3 or C^{14}) adapted to a microscope and microlocator slide.

PROBLEM ROS-1 Constant Velocity Vehicle For Small Laboratory

The investigator wished to study injuries to internal organs by utilizing experimental animals in a simulator in a small laboratory. A means to

to attain constant speed of 20-30 miles per hour with a minimum run or track is needed. The problem originator wants a constant velocity vehicle simulator for crash impact studies with primates.

PROBLEM SWC-12 Detection Of Eye Tumors By Use Of Radiation Probes

Eye tumors are more easily treated and prognosis is favored when early detection is possible. Some tumors can be detected by direct observation. Hidden tumors and tumors in very early stages sometimes must be located and identified by measuring the difference in radiation levels known to exist because tumor cells selectively absorb (uptake) radioactive materials.

Present radiation probe is inadequate. The probe must be able to detect in excess of 10 percent of beta radiation ranging up to 1.7 MEV (average 0.7 MEV) energy from P-32. The miniature geiger probe will be inserted between the eyeball and eye socket to various quadrants to measure linear energy transfer on a linear accelerator.

An appropriate miniature radiation probe was identified. Efforts are in progress to adapt this instrument for use in treating eye tumors. The engineering effort is expected to be finished soon and the probe will be delivered to the program originator.

PROBLEM MDA-1 Radiation Resistant Tilt Table For Use In Radiotherapy

Materials are needed to design and fabricate a patient tilt table which does not accumulate large amounts of radiation from neutron bombardment. Radiologists in a large hospital are in the developmental stages of massive tumor treatment by fast neutrons generated by bombarding Berrylium with Deuteron. They plan to use a Cyclotron. Present problems involve finding a suitable material to fabricate the patient tilt table. This material ideally should be able to withstand the bombardment of thermal and epithermal neutrons without accumulating radio activity.

ECOLOGY

PROBLEM TAM-2 Synthesis Of High Protein Food From Raw Materials

A systematic, ecologically efficient means to produce food will be needed as agriculturally available land space is required to house an expanded population. Efficient and economically produced high protein food supplements have been developed from agricultural and oceanic products. A long term goal is seen requiring production of these foods from basic raw materials. Studies of food synthesis affect projected interplantary space flights.

Devices, methodology, materials, and chemicals must recognize economic feasibility factors. It would be desirable to recycle human byproducts and waste products as raw materials. The resultant foodstuffs must be safe for human use.

HEALTH CARE COST REDUCTION

PROBLEM SWC-4 Information Retrieval System For Clinical Records

The investigator needs to retrieve information from a computer bank on one-half million clinical records in a medium-sized hospital having 80,000 annual admissions. He particularly desires information from the records relating to specific medical treatment, disease prevention, and trend identification in medical treatments. He seeks to perfect techniques for providing guidance in cryptic disease treatments by computer analysis. Sophisticated data processing equipment (IBM Computer Model 360) is available at the hospital but no software programs are available for the outlined task. The problem originator sought NASA technology assistance for his problem.

A team visit to the NASA Manned Spacecraft Center provided information concerning Dr. E. C. Moseley of the Medical Research and Operations Directorate and his development of some general computer programs for use in the Medical Information Computer System (MEDICS) program These programs appeared to solve the problem. They consist of:

- Storage of Medical Records in Retrieval Form
- Retrieval of Medical Data According to Specifications
- Updating of Medical Data Bank

PROBLEM SJH-2 Interface Schematics For Incorporation Of Biochemical Autoanalyzers To A Computer

The problem originator in his quest to automate the retrieval of biochemical data has acquired CLINC programs which will enable him to utilize a computer with his autoanalyses when suitable interface circuitry is developed. He needs NASA schematics of interface circuits used with his programs.

PROBLEM CMR-2 Call Signal For Quadriplegic Patients

Multiple amputee patients and patients paralyzed in all four of their extremities (quadriplegics) are unable to operate the usual call-switch to obtain nursing assistance. These severely limited patients usually need

more nursing care than other hospital patients. The only solutions in the past have been to provide costly,full time nursing attendance or schedule frequent and wasteful bed stops by the nursing staff. These patients are able to perform limited lifting and rolling head and neck movements. Proposed methodology should be easy to install and operate and should avoid discomfort, distractions and other interferences with normal hospital routines, patient's sleep, etc. The technology should be safe for patients and readily adaptable for use with body positioning adjustments of hospital beds.

PROBLEM BMC-5 Computerized Management Program For Hospital Staff Scheduling

Design and methodology software adaptable to the daily scheduling of hospital staff personnel to service all assignments are needed. Increasing headcount within hospitals reflects in added responsibilities for a fixed staff or corresponding increases in staff unless more efficient management can be applied. Control of scheduling of staff personnel to adequately fill all required assignments (e.g. nurses to work in surgery, etc.) is critical to hospital operation. Excessive manhours are presently required to lay out and manage duty rosters. A computerized software program is needed which can handle multiple rosters to provide daily readouts for scheduling purposes. The program should permit easy input of adjustments to allow flexibility concerning absences and other availabilities or unavailabilities. Applicability of the program should provide relief to a large number of hospitals that currently have access to computers.

PROBLEM PPR-1 Home Paging System For Reminding Elderly Patients of Medication Times

A device to remind elderly patients to take their prescribed medication at the correct ime is needed. Elderly patients under medication often forget to take their medicine. A device that would remind the patients at the proper time to take particular medication would greatly enhance the general health of the patient and reduce the overall cost of medication because of lost dosages. Because of different medication, an audio system is envisioned. Perhaps a tape loop that can be programmed by the physician. Sealed instructions are necessary for patient safety.

PROBLEM UAM-8 Improved Hospital Electrical Safety Procedures During Patient Monitoring

Between 1,200 and 12,000 patients annually are estimated to be shocked during their hospital treatment. Some of the shocks are fatal and many hospital fatalities have not been recognized as caused by electrical shock.

Patients and hospital staff members frequently are exposed to many diverse and complex electrical connections. The problem originator seeks electrical safety standards to provide adquate protection for all types of equipment and procedures. Safeguard grounding of supplies and equipment is needed to prevent discharge of current into personnel. Static electricity and sparks are dangerous since they can cause shocks and also can ignite combustible gases and supplies used in patient care. Electrical safety standards and NASA technology relating to improved techniques for reducing shock hazards have been provided to the problem originators.

PROBLEM USC-3 A Secure Method For Patient/Specimen Identification

More efficient and economical acquisition and utilization of clinical test information is needed. A suitable means for data acquisition, analysis, recording, and billing is required for automation of clinical laboratories. A secure means for patient/specimen identification is a vital need. It must be available if a high degree of automation of clinical laboratories is to be achieved. It must permit accurate and rapid marking and reading of samples. The samples may be in a variety of containers, such as glass tubes, petri dishes, etc. Plastic-tab attachments to specimen containers have proved to be unsatisfactory. Radioactive coding and mechanical identification, drilling or scoring also have been suggested. Many different means have been unsatisfactory to private and commercial concerns because of misidentifications and other confusions. This problem constitutes a major roadblock in automation efforts. The problem originator sought NASA technology assistance for unique approaches to identifications of specimens leading to automated readout and correlation of specimen identify, test data, data analysis, and patient billings. This will provide maximum clinical laboratory benefits at minimum costs in all areas.

PROBLEM MHB-1 Out-Patient Clinic Computerization For County Hospital

Computer methods for fast and accurate screening and record filing in county hospitals are needed. Birmingham Mercy Hospital is to be fully computerized and problem originator desires to include multiphase health screening and computerized record files in the out-patient clinic. The hospital is to have extensive computer facilities, thereby allowing a wide range of applications.

PROBLEM MHB-2 Computer Programs For Health Care Improvement

Computer programs to assist in presentation of lower cost medical care are needed. The problem originator is attempting to apply computers to

X-ray, laboratory, intensive care, and other phases of the hospital system as the needs are identified. He is aware that NASA has programs that may well fit his needs.

PROBLEM LVA-4 Research Facility, Design, and Planning

The problem originator is planning to build a new medical research facility which will require a multi-story building, zonal air conditioning, interchangeable modular cabinetry, and optimum flexibility of modular laboratories and training space. It must accommodate regular and part-time staff members. Research will be broad, even though concentrating on biochemistry and neurophysiology.

PROBLEM NMA-1 Program To Establish Electrical Safety Standards For Equipment and Instruments Used Around Patients

A means is needed to establish a comprehensive set of electrical safety standards for equipment and instruments used around patients. Doctors and hospitals are concerned about the current tolerances in equipment and instruments around the patient in surgery and the intensive care unit. A great deal of electrically powered equipment comes in contact with patients in these situations and some of it has caused problems. A limit can be set to require manufacturers to cut down on leakage current if their devices become disconnected to a ground. Standards must be set for total leakage current around patients. Reasonable standards also must be set for instruments, beds, stands, monitoring and therapy equipment, as well as power cords and sockets. The problem originator requested NASA technology help in this large problem area. Several possible leads to the solution of the problem were retrieved from a search of the NASA Data Bank. The overall solution will entail proper formulation of a program specifically tailored to hospitals.

KIDNEY DISEASE DETECTION AND TREATMENT

PROBLEM BLM-17 Improved Procedure To Measure Regional Blood Flow In Kidney

A renal physiologist is investigating the microcirculation of blood in various layers of the kidney in ongoing research into kidney function and operation. Rigid electrodes are inserted into the kidney with micromanipulators while the kidney is lying in a cup outside the body during hydrogen-washout techniques. The investigator needs suitable electrodes to implant and measure regional blood flow in situ. Observations must be repeated on the animal over long periods of time.

PROBLEM DLM-14 Detection of Kidney Stones During Surgery

A physician urgently needs a method or instrumentation to detect small stones in the kidney during surgical procedures. Larger renal calculi (stones) can be removed with surgical techniques. The smaller calculi are difficult to locate and remove, however, and commonly cause recurrence of the calculi problem with a requirement for repeated surgery. This repeated surgery increases both hazard and expense for the patient as well as inconvenience. The required technology must be accurate, reasonable in cost, relatively easy to operate, and adaptable for operating room use. Roentgenography, which has been useful in establishing the presence of large renal calculi, has been inadequate to identify the smaller calculi. Improved radiographic techniques or ultrasonics may provide applications to solve the problem.

PROBLEM MVA-2 Measurement and Recording of Urine Flow

The technological methodology and a device to measure urine flow and to provide an electrical signal for recording volume/time are needed. It is not necessary to monitor urine flow internally. Simple catheterization and collection into a bag where the urine can be volumetrically measured is too gross a measurement for this need. Flow measurement can be made externally.

REDUCTION OF INFANT MORTALITY

PROBLEM SNM-13 Miniature pH Electrode For Fetus

Researchers are seeking supplemental physiologic information concerning the infant's well-being as the birth process begins. Measuring the in vivo pH of the fetus during labor may provide such information. A pH probe for this purpose necessarily has unusual requirements and this fact complicates solution for the problem.

PROBLEM SNM-14 Fetal ECG Telemetry

The problem originator seeks to telemeter fetal ECG with clip-on electrodes to provide better obstetrical care, specifically during labor and birth. A transmitter will be inserted at the onset of labor to monitor continuously until birth. Bulky, hard-wire instrumentation is used for this purpose and it decreases mobility of the patient. The required transmitter must be small enough to insert into the uterus and must be nonirritating during the course of labor. It should transmit at least 10 feet and have a useful life of 10 hours.

PROBLEM SNM-15 Uterine Pressure Telemetry

The problem originator seeks to monitor a pregnant patient's uterine pressure during labor to provide better obstetrical care. The data must be telemetered

over a short distance. He currently measures the pressure by hard-wire instrumentation. This is encumbering to the patient and he feels telemetry could provide optimized care. He needs an implantable pressure telemetry unit which would be able to transmit for 10 feet, have a useful life of 10 hours, and be noninjurious to the uterus or the fetus throughout the period.

PROBLEM SMN-26 Monitoring Of Pelvic Pressure Of Women During Labor

A portable monitoring and recording system capable of recording and monitoring pelvic pressure in pregnant women is needed. Monitoring pregnant women in labor to evaluate physiological conditions can lead to better understanding the mechanism of labor and birth. This could also lead to the prevention of complications at birth and perhaps save lives. The problem originator desires a means to monitor and record the pelvic pressure of women approaching delivery. Subjects are available for the large scale study being conducted in Rhodesia. Data collected will be analyzed. The recorder must have capability of measuring DC levels which are indicative of pressure.

RESPIRATORY DISEASE DETECTION AND TREATMENT

PROBLEM OVA-2 Measurement of Lung Compliance

The lung volume-pressure relationship is measured by having a patient breathe into a closed system to assess function of the lungs. The data acquisition is time consuming, involves bulky equipment, and is difficult to perform when the patient is seriously ill. The indications are suitable for bases of gross diagnosis. Subtle abnormalities or changes are not readily detectable. A reliable, convenient, and atraumatic method is needed to measure pulmonary compliance of the lung by the signaling rate and volume of airflow. It must be possible to sterilize the temperature and moisture insensitive transducer or head. It can be attached to a standard endotracheal tube through which the patient breathes or through which he is ventilated by a respirator. Acoustic or mechanical vibration may be applicable.

PROBLEM GVA-6 Respiration Monitor

Cardiovascular patients require certain respiration studies. Analysis of the expiration cycle of tidal volume measurements are compared with the respiration rate, pO_2 and O_2 concentration to accurately describe the pulmonary well-being. The problem originator needs techniques to monitor respiration rate, pO_2, O_2 and analyze expiration waveshapes.

PROBLEM TCH-1 Quantification Of Biochemical Changes In Striated Muscle Due To Inactivity

The problem originator uses standard micromethods to determine muscle cell levels of water, fat, sodium, potassium, calcium, magnesium, protein, adenosine triphosphate and water soluble nitrogen. He plans to establish treatment schedules for chronic, bedridden, iron lung patients. He needs assistance to develop reliable and rapid techniques and is particularly interested in the potassium microtechniques available. Methodology must be safe to use with patients. It should be on the order of a microprobe which can evaluate small sections of biopsy materials. The researcher is willing to travel to any applicable NASA technology and evaluate it onsite if necessary. The researcher was advised of the availability of an electron microscope and microprobe at Houston Manned Spacecraft Center.

PROBLEM FTZ-1 On-Line Breath Analyzer

An accurate, reliable, on-line analyzer to identify contents of expired gases is needed. The researcher is specifically interested in the analyzer described in the NASA document N70-25476 "Astronaut Breath Analyzer," He also is interested in other on-line devices that measure these parameters.

PROBLEM FTZ-2 Invasive Means For Measuring Blood Gases

The researcher need to measure blood pO_2, pCO_2,and pH on-line with needle electrodes. He is searching for an accurate, relatively economical and convenient method which does not require blood sampling. A system to measure blood gases in critically ill patients is needed. Small needle electrodes will be acceptable.

PROBLEM ROS-2 Method For Measuring Blood Gas Without Breaking The Skin

Accident victims and critically ill patients must be quickly diagnosed with minimum trauma. Knowledge of blood-oxygen would be very useful in many instances. An atraumatic, skin-contacting method for measuring pO_2 in the blood is needed.

PROBLEM WLH-2 Device To Clinically Evaluate Nasal-Airway Obstructions

A means is needed to clinically evaluate effects of medication, desensitizations, and surgical corrections for obstructions and other airway problems. Nasal problems are present in a large number of patients seen daily in this large facility. The problems may represent vasomotor rhinitis, nasal septal deflections, ansal polyps, etc. Treatment may consist of systemic or topical

medications, desensitization when allery is the underlying etiology, surgical correction of mechanical obstructions, and a variety of different problems with parallel or different regimens of treatment. The effects of the different kinds of treatment should be monitored and evaluated to assess the changes as they occur in each patient. One of the major parameters requiring evaluation is the status of airflow measurement under clinical conditions.

PROBLEM CLA-3 Alarm Circuitry for Apnea Telemetry

An alarm circuit to be incorporated into the apnea telemetry device is needed. The problem originator has evaluated a NASA developed respiration monitor which utilizes telemetry to send respiration signals to a central nurse station. He now desires to have an alarm which will sound when respiration ceases It must fit into existing telemetry unit. NASA technology has been identified.

PROBLEM RNV-39 Development of Proper Procedures and Observation of Human Subjects in Medical Research

Technology and methodology are needed relating to practices, policies and protocol appropriate to medical research with human subjects. The problem originator is part of a large research staff which is investigating the effects of air pollutants on physiology and pathology processes. They are presently developing and directing a research program aimed at determining the effects of pollutants on human lung function. Professional human subjects will be involved in these controlled studies. Input is needed to resolv problems affecting the experimental design and data interpretation when trained, professional human subjects are employed. They would like to be able to rule out false negative responses if highly motivated subjects were able to overcome mild environmental stress. They anticipate that less noisy baseline data from trained subjects may filter out some sensitive responses.

PROBLEM HPH-1 Particle Detector Monitor for Clean-Room Surgery

A particle detector system to monitor the output of the air balance filters for clean-room orthopedic surgery is needed. Prevention of infections is essential to improved patient care in a hospital. Control of infections is critically important for orthopedic surgery because of the added hazard when prosthetic hardware is used in the surgical openings. Low grade infections (some delayed 3 to 5 years postsurgery) have been significantly lowered in rate whenever clean-room surgery was employed. The problem originator proposes to use a monitor system to detect particles at air filter outputs to assist in ensuring clean-room conditions.

PROBLEM MHH-1 Rapid Identification of Surgical Instruments

A means of identifying surgical instruments in a large metropolitan hospital as quickly as they are removed from sterilization units. All surgical instruments are sterilized centrally in this hospital. Physicians prefer to have individual sets of instruments. There needs to be some method of rapidly identifying each physician's instruments as they are removed from the autoclave or ultrasonic cleaner. Personnel can not take the time to meticulously examine each instrument ot identify same. Some form of color coding is desired. Vibro-tools ruin the finish on

the instruments and is deemed unacceptable for the preservation of aseptic conditions. Material to be used must withstand
1.) Ethylene Oxide Sterilization
2.) Autoclave 278° @ 30-psi
3.) Ultrasonic Cleaner

PROBLEM UTM-37 Butt-Welded Fine Gauge Wire

Severed human tendons have been surgically sutured with a variety of materials, including wire, to hold them in place during healing. Further surgery usually is required to remove the wire after healing. Excessive scarring has frequently resulted in spite of the best techniques developed for such procedures. The problem originator seeks to avoid such problems by inserting fine gauge wire within the tendon cut-ends. Resilient, biocompatible wire size (20 to 24 A.W.G.) 0.020 to 0.030-in.; with 8 barbs/cm and 0.004 to 0.005-in. diameter is to be butt-welded to the central core, rotated every 0.25 centimeter. The barbs are to be welded at about 135° with the core axis and should flex on insertion for minimum resistance and catch in the tissue without inverting for maximum resistance against pull-out. Stainless steel or suitable equivalent is suggested.

DETECTION AND TREATMENT OF DENTAL AND ORAL DISORDERS

PROBLEM DEV-2 Fast Fourier Transform Capability

Hardware or hardware details to convert a 128-x 128-image field to a digitized format and computer software to represent a two-dimensional, 20-x 20-channel filter, and FFT programs to transform between image and Fourier representation are needed. A 2-dimensional radio nuclide image (similar to an x-ray film) is obtained clinically. The problem originator has developed his own enhancement filter functions (in FORTRAN) which he wishes to apply to the image.

PROBLEM UAD-1 Tooth Movement Sensor

A transducer to indicate tooth movement in socket during mastication is needed. Oral surgery and bridge rebuilding require accurate knowledge of teeth position (primarily heights). When upper and lower jaw are brought together, any mismatch will lead to muscle fatigue in the jaw, speech problems and enamel breakdown because of wear on high spots. Transducer must be mounted on side of tooth so as to not inhibit bite in any way. .001" difference in bite is sufficient to negate accurate readings setting the side mounting requirement. Problem has been identified and a search initiated.

PROBLEM UAD-2 Tooth Position Within the Socket

A means of measurement of tooth mobility and position during treatment of pyorrhea alveolaris is needed. To check progress in pyorrhea treatment on a weekly basis, the problem originator desires a transducer method of determining position and mobility of the teeth. As treatment progresses, mobility should decrease and position should become relatively

stationary. Problem has been identified and a search initiated.

PROBLEM UAD-3 Determination of Tooth Vitality Due to Nutrient

An instrument capable of measuring tooth temperature to determine if blood flow into the tooth exists is needed. Reconstruction of jaws, gums, and teeth in people who suffer accidents or foul play alwasy have their teeth fixed immediately and then checked two weeks later to determine if surgery was successful. The problem originator wishes to be able to determine objectively if the tooth hav been saved or if the blood supply has fialed to keep the tooth alive. To date, best methods are merely guesses.

PROBLEM UAD-4 Tooth Vitality as Measured by Nerve Condition

A means of measuring nerve vitality from crown to root on questionable teeth is needed. Teeth that are dead or failing because of loss of innervation are difficult to detect objectively. Problem originator would like to place a stimulus on the crown and sides of the tooth and be able to monitor a signal coupled by the nerve indicating the condition of the nerve. A restriction necessarily would include guarding the input circuitry against the obvious drive through pulse traveling along the tooth exterior.

PROBLEM UAD-5 Preparation of Dental Material Samples for Microscopic Analysis

Methods to prepare dental material samples uniformly 50 -100 microns thick with planor side surfaces are needed. Present methods of preparing this samples of dental material are not accurate enough to provide reliable information on density, crystalline structure, hardness. The problem originator deisres a method of preparing samples 50 - 100 microns thick with sides perfectly parallel.

PROBLEM UAD-6 Microhardness Analysis of Tooth Enamel

A microstylii system capable of producing (1-5) micron identations in tooth enamel samples is needed. In the pursuit of definition of the formation of dental caries, the problem originator is involved in determining the hardness of tooth enamel with various agents. Since the structure of enamel is much like that of a plowed field microscopically, the problem originator needs a microstylii capable of making (1-5) micron lengths indentations in tooth enamel samples. The first portion of the problem is the size limitation. Once this has been solved, he wishes to make a jig such that known forces can be applied repeatedly.

PROBLEM UAD-7 Telemetry of Oral pH for Determination of Linkage to Formation of Cavities

A microminature telemetry device to transmit oral pH to a nearby receiver is needed in dental research. The problem originator feels that early formation of enamel breakdown and subsequent decay is closely linked to the oral pH. To prevent wires from hanging out of the mouth, telemetry is preferred.

BASIC MEDICAL RESEARCH PROBLEMS

PROBLEM LVA-5 Device for Weighing Laboratory Rats

Rats are confined in an inflatable plastic chamber and are being studied for trace element deprivations. The individual rats must be weighed periodically without removing them from isolation and without exposing them to metallic apparatus. Researchers have detected noticeably "cold feet" on animals that have been deprived of certain trace elements. Deep body temperature previously has been observed. The researcher seeks an integrated instrumentation enclosure which simultaneously acquires ECG, foot pad temperature, and weight. Each test colony will contain 32 rats. The method should be rapid, convenient, and minimally restraining within the isolation chamber.

PROBLEM LVA-7 Method for Acquiring ECG Information from Laboratory Rats in Isolation Chambers

Rats are confined in an inflatable plastic chamber and are being studied for trace element deprivations. Rats must be handled minimally and avoid exposures to metallis apparatus. The researcher seeks an integrated instrumentation enclosure which simultaneously acquires ECG, foot pad temperature and weight. Each test colony will contain 32 rats.

PROBLEM PVA-5 Low-Noise EEG Preamplifiers for Clinical Research

A California research in experimental physiology needs a small, low-noise preamplifier which can be attached very near the EEG electrodes. The system currently in use is excessively noisy. The solution should provide a schematic since the circuitry is to be custom-packaged and the schematic will facilitate self-fabrication.

PROBLEM USC-9 Methods for Obtaining Otological Response in Experimental Animals

Human otological responses are measured by recording the skin potentials generated by eye movement. The problem originator needs an improved method for measuring this indirect response, or some means for measuring a direct response.

PROBLEM TCM-3 Peak Detector for Signal Conditioning of Blood Velocity Measurement in Basic Medical Research

Erythrocyte velocity is measured in microcirculation studies of capillaries which supply blood to critical organs. The problem originator intends to apply better understanding of these organs in his research of diabetes and other organ breakdown studies. Erythrocyte capillary velocity is photometrically acquired. The erythrocytes pass over two slits where two phototubes measure and present transit-time information to a correlator. The problem originator seeks to generate sharp pulses at the instant of passage to improve the methodology. Better definition of erythrocyte passage time requires technology which will read the peak analog signal and then generate a pulse at the peak.

PROBLEM OVA-5 Nonencumbering EEG Electrode Assembly Suitable for Long-Term Sleep Research Application

A nonencumbering EEG electrode assembly suitable for long-term sleep research application is needed. An extensive research program is being conducted involving sleep and activity problems at the South Pole. The aim, among other factors, is to assess the influence of a unique set of stressful environmental factors upon sleep patterns, duration, and quality, reflecting the adaptational methods and capacity of a given individual. The program involves acquisition of EEG data during extended periods, without distrubing the sleeper. The existing hard helmet is inadequate for long term acquisition of sleep EEG data due to discomfort and artifacts introduced during movement associated with the sleep state. A nonencumbering EEG electrode assembly is required which is free from movement induced artifacts. The EEG electrode assembly must be comfortable, non-encumbering and free frommove ment-induced artifacts. It must be capable of functioning for long periods without adjustment (up to about 8 hours).

PROBLEM IOU-1 Method for Measurement of the Amount of Humidity Present in the Lower Respiratory Tract

An instrument or technique which will assist in determining the most effective method of administering humidity to patients with a tracheostomy or a laryngectomy is needed. It is well documented that humidity is needed when the upper respiratory tract (nasopharynx) is by-passes (as in a tracheostomy) with air being inspired directly into the trachea. Administering humidity in this context helps : (1) thin pulmonary secretions; (2) maintains a patent (open) airway with adequate alveolar ventilation; (3) prevents the occurrence of complications which can be fatal and (4) provides for patient comfort by preventing dryness in the respiratory tract. At present, there remains a question about the kind and degree of moisture required by tracheostomized

patients. An answer to this important therapeutic question requires the availability of a valid means for determining the amount of humidity present in the lower respiratory tracts. A possible approach would be to measure the viscosity of small amounts of asperated pulmonary secretions (usually less than 1 ml). These secretions are generally semisolid fibrous gels with biorheologic properties. Changes in viscosity attributable to administration of humidity by one of the several available techniques would be a valuable indicator of therapeutic effectiveness of the humidity administration method under consideration.

PROBLEM SWC-6 Apparatus for Micropuncture of Pancreatic Gland

The basic research of the problem originator relates to cystic fibrosis as it affects children. The investigator requires a subminiature electronic device to micropuncture ducts and cells of the pancreas for in vivo chemical analysis of various inorganic ions and enzymes.

PROBLEM SJH-1 Interfacing Biochemical Autoanalyzers with a Computer

The problem originator seeks to increas the efficiency of the pathology department and medical costs-to-patient by interfacing biochemical autoanalyses to a SMN-12-60 computer. He has requested available NASA technology concerning the required logic and necessary programming to acquire autoanalyzer outputs and convert them for analysis and summary by computer. He requires a fixed window or variable window gating system to peak-read autoanalyzer signals and a program to acquire a cumulative summary report.

PROBLEM CHS-3 Multiple Electrode Stimulation of the Cochlea

A system of multiple (20 to 30) electrodes mounted on flexible plastic for insertion into the cochlea of the human inner ear is needed. The researcher has been attempting to transmit electrical pulses via electrodes inserted within the cochlea of the inner ear, with a range of 3 to 200 pulses/second. Three pulses/second applied to appropriate cochlea regions may sould like a 1000 Hz tone - another region may yield a 3000 Hz tone, etc. Pulses transmitted through cochlear fluid will stimulate auditory fibers within a 5 to 10 mm area (although possibly 1 to 2 mm). Insertion material with three to four electrodes have been used. The increased numbers will expand research. Gold or platinum is suggested as a suitable biocompatible material. Electrodes should avoid overlap for transmission of the pulse. They should be able to handle 300 to 500 microamp pulses from an electrical source. Lead wires must fit a diameter of 0.5 mm. Insulation should be provided to avoid leakage and electrodes should minimize polarization. Pulses will be distributed among electrodes to approximate auditory configurations.

PROBLEM CHS-7 Auditory Center Brain Implant Electrode

The researcher has been studying cat responses to stimulation of auditory centers by means of hard wire electrodes implanted within the brain. The electrode assembly is held in the end of a hollow needle during implantation. Glial cells appear to attach themselves to the implanted system and hold it relatively firmly in place. Present materials have not been sufficiently precise in configuration and this has delayed research. A biocompatible electrode for long term (balance of lifetime) implantation into auditory brain centers to stimulate responses is needed.

PROBLEM RRC-7 Oscilloscope Synchronization for Electromyographic Needle Manipulation

Technological methodology or device to initiate an immediate triggering of an oscilloscope sweep upon movement of EMG needle is needed.

It is possible to control the operation of a recording oscilloscope in a free-running mode, internal synchronizing and external synchronizing. The problem originator is clinically investigating the electromyographic (muscle electrical energy) impulses of different muscle layers. He needs a means to tripper a synchronizing sweep of the oscilloscope based on the insertion movement of the needle as it is moved from a layer of muscle to a deeper muscle layer. The investigator feels that important signaling is lost from the electromyographic reading if the synchronization were to wait for a definite pattern to develop after muscle reactions to the needle movement subside. He feels important signals are present and should be monitored immediately.

PROBLEM GLM-35 Beta Radiation Catheter Probe

Cerebral blood flow must be monitored to determine effectiveness of therapy applied to head injury patients. Few data points per patient can be obtained if blood samples have to be drawn and laboratory tested. Technology is required to repeatedly determine arterio-venous concentration differences of Krypton-85 showing cerebral blood flow without need to draw blood from patients. Determinations are needed continously over a period of time on the same patient. A biocompatible catheter probe for detecting concentrations of weak beta radiation from Krypton-85 circulating in human arteries and veins is needed.

The probe must be biocompatible, sensitive to beta radiation, tolerant to x-rays encountered during fluoroscopic implantation, able to withstand exposure to biological fluids (blood) for several days, non-toxis, sterilizable, and safe for use in the human body. The probe must use low voltage because of risk to human life.

A miniature solid state radiation probe developed by NASA was identified. Applications engineering efforts are in progress to build a probe for use by the problem originator.

PROBLEM GLM-37 Activity Telemetry from Single Neurons in Aquatic Animals

Biocompatible, high impedance microelectrodes are needed for implantation in nerve tissue of freely swimming fish.

Basic research into motor control mechanism study is fundamental to treatment of defective motor control. Implanted sensors will detect central nervous system activities of single neurons in the vestibulospinal pathway of 2-foot long experimental fish. Neuron activity observation in the unrestrained animal relates unit activity to whole animal behavior and assesses the mechanism by which this system controls movement. Anesthetized animal acute experiments also will be performed in this study.

The amplifier should detect signals in the order of 100 microvolts with 100 to 5000 Hz bandpass. Signals from the fish in a tank must pass through sea water. Microminiature apparatus to be fastened to the skeleton of the fish should not interfere with normal movement patterns. If ultrasound is to be considered, the sound must not cause the fish to change movement patterns. The waveform of the nerve impulse must be distinguished from artifact and other nerve impulses, and therefore should not be appreciably distorted.

PROBLEM UAM-3 Chronic Micro-Miniature L-C Transducer/Transmitter Implants Within the Human Eye

Biocompatible techniques for sealing of chronically implanted transducers and transmitters within the human eye are needed.

Pressure and temperature must be measured within the eye of a patient during convalescence following eye surgery or eye injury. These parameters indicate conditions of healing to the attending physician. The problem originator intends to chronically implant micro-miniature L-C transducers to obtain the desired eye measurements. Convalescence extends for months in some instances. Therefore, it is necessary that the transducer be effectively sealed.

PROBLEM UAM-5 TV Study of Cell Fluorescence under Low Light Intensity Conditions

Certain chemical actions occur during the study of amino acids, proteins and their synthesis which yield spectrums that are specific to their make-up. Living cells checked with a microspectral polarimeter will yield the same spectrum if the same proteins are present. Synthetics can be compared in this manner to the in vivo conditions. An orthicon tube or isocon tube television system for low light intensity fluorescence

studies is needed.

PROBLEM ROS-1 Constant Velocity Vehicle for Small Laboratory

A constant velocity vehicle simulator for crash impact studies with primates is needed. The investigator wishes to study injuries to internal organs by utilizing experimental animals in a simulator in a small laboratory. A means to attain a constant speed of 20 to 30 miles per hour with a minimum run or track is needed. Economical construction is required. Terminal speed must be selectable and the vehicle should be able to accommodate large baboons or chimpanzees.

PROBLEM LLU-10 Noninvasive Techniques for Measuring Oxygen Content of Blood

Physicians conducting research on head injuries need new methods to measure and observe certain vital signs. They require noninvasive techniques to measure the oxygen content of blood.

PROBLEM OVA-4 Method for Assessing Sleep Psychophysiology in Extreme Environments

Extreme, exotic, and stressful environmental conditions are encountered at Amundsen-Scott Station, Antarctica. The investigator is assessing generated, long-term psychophysiological responses to use in constructing an overall picture of the general processes of adaptation and maladaptation. He collects and analyzes the psychophysiological concomitants of sleep (as a definitive state of consciousness). Phase 4 sleep dropout was noted. Instrumentation must be reliable under extreme environmental conditions and continually assess individual's state of consciousness.

A NASA-developed electronic sleep analyzer was identified through a search of aerospace literature. The problem has been submitted as an applications engineering candidate and promises to be a significant application of aerospace technology.

PROBLEM GLM-40 Telemetry from Divers

Most of the data accumulated about physiological changes of divers exposed to below-shallow depths have been predicted from competent estimates of what could be expected and from rather sketchy information available as a result of accidents, experiences, etc. The increased numbers of people who are diving and the increased depths to which they are exposed creata a need for underwater monitoring data. The transmitter and system must be functional in, and resistive to, salt concentrations of sea water. The device should be about flashlight size to allow holding in hand during operation. The signals must be reliable and reproducible with a backup system if necessary.

PROBLEM UOF-2 Low Level Noninvasive Blood Pressure Measurement

A blood pressure monitor capable of being used concomitantly with EEG monitoring is needed. Blood pressure will have to be monitored with low level signal sources to prevent swamping of EEG signal. An arm cuff is too uncomfortable for long-term usage.